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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATOR, ORGANIZATIONAL, DS, GS, AND DEPOT MAINTENANCE MANUAL

OSCILLOSCOPE AN/USM-117B

HEADQUARTERS, DEPARTMENT OF THE ARMY

AUGUST 1966

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Units organized under following TOE's: 2 each.

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NG: State AG (3).

USAR: None.

For explanation of abbreviations used, see AR 320–50.

TEMPORARY CHANGE T-1 to TECHNICAL MANUAL FOR OSCILLOSCOPE AN/USM-117 NAVSHIPS 94344(A)

The purpose of this temporary change is to correct errors in the technical manual.

Maintenance Support Activities and holders of equipment accompanied by technical manuals shall make this change in the technical manual immediately.

Make the following pen-and-ink corrections. Insert this temporary change in the technical manual immediately after the front cover and preceding the title page.

1. Change the locating function of T301, on page 7-60, to read "figure 6-19".

2. Change the locating function of T301, on page 7-63, to read "figure 6-3".

3. Change the reference designation of T301 in table 7-1, page 7-63, to read "A301".

DEPARTMENT OF THE NAVY
BUREAU OF SHIPS
WASHINGTON 25, D. C.

IN REPLY REFER TO
Code 242-100

From: Chief, Bureau of Ships
To: All Activities concerned with the Installation, Operation, and Maintenance of the Subject Equipment

Subj: Technical Manual for Oscilloscope AN/USM-117, NAVSHIPS 94344(A)

1. This is the Technical Manual for the subject equipment and is in effect upon receipt. It supersedes NAVSHIPS 94344. Upon receipt hereof, NAVSHIPS 94344 shall be destroyed by burning

2. When superseded by a later edition, this publication shall be destroyed.

3. Extracts from this publication may be made to facilitate the preparation of other Department of Defense publications.

4. Errors found in this publication (other than obvious typographical errors), which have not been corrected by means of Temporary Corrections or Permanent Changes should be reported. Such reports should include the complete title of the publication and the publication number (short title); identify the page and line or figure and location of the error; and be forwarded to the Publications Section of the Bureau of Ships.

5. All Navy requests for Bureau of Ships electronic publications should be directed to the Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania.

R. K. JAMES
Chief, of Bureau

RECORD OF CORRECTIONS MADE

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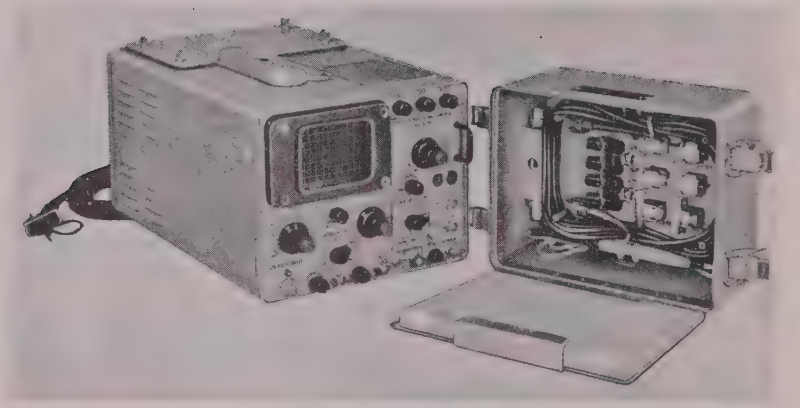


Figure 1-1. Oscilloscope AN/USM-117

SECTION 1
GENERAL INFORMATION

1-1. PURPOSE OF TECHNICAL MANUAL.

The purpose of this technical manual is to supply information which will assist in the installation, operation, and maintenance of Oscilloscope AN/USM-117. Failure to follow the procedures outlined in this manual may result in incorrect operation, improper maintenance procedures, and generally poor performance of the instrument.

1-2. FUNCTIONAL DESCRIPTION.

Oscilloscope AN/USM-117, shown in figure 1-1, is a transistorized general purpose portable test instrument, suited for a wide variety of waveform viewing applications. It may be used at any base, field installation, or aboard ships having a power source of 115 volts at 50, 60, or 400 cps available. The circuits of the instrument function as follows:

The low voltage power supply provides regulated dc for all circuitry throughout the instrument.

Vertical Plug-in MX-2996/USM-117 is a high gain preamplifier having a basic 10 millivolts per division sensitivity with five megacycle bandpass. Vertical Plug-in MX-2995/USM-117 is a dual trace preamplifier having a basic 50 millivolts per division sensitivity with five megacycle bandpass.

Output signals from the vertical plug-in preamplifier are further amplified by the vertical post amplifier and then delayed before being applied to the vertical deflection plates.

The horizontal amplifier selects either external or internal sweep signals and provides the horizontal deflection signals

for the crt. Magnification of the sweep is accomplished by increasing the sensitivity of the output amplifier by a factor of five.

The sweep trigger selects internal, external, or line triggering signals and provides an amplified sharp positive-going spike coincident with the trigger input waveform, which is used to actuate the sweep generator.

The sweep generator provides a time base display at the desired sweep speed and provides a wide range of calibrated sweep speeds to 0.1 microsecond per division. The sweep may be either triggered or free-running. A positive-going gate waveform, used to synchronize external equipment, is also derived from the sweep generator.

An internal voltage calibrator provides two accurate amplitude square wave outputs which are used as a reference for accurate amplitude measurements.

1-3. FACTORY OR FIELD CHANGES.

Since Oscilloscope AN/USM-117 is a new instrument, no factory or field changes have been made at the time of this writing. For possible changes effected at a future date, refer to the Electronic Installation and Maintenance Book (EIMB), NAVSHIPS 900,000.0. This book contains a complete field change index.

1-4. QUICK REFERENCE DATA.

Oscilloscope AN/USM-117 consists of an indicator unit designated OS-106/USM-117 and a plug-in preamplifier designated MX-2996/USM-117. Reference data for these units is as follows:

a. HORIZONTAL AMPLIFIER CHARACTERISTICS.

(1) BANDWIDTH. – Dc to 500 kc, within 3 db.

(2) SENSITIVITY. – Three ranges provide sensitivity figures of 0.5 volt per division, 1.0 volt per division, and 2.5 volts per division. The HORIZ GAIN control provides a variable sensitivity adjustment between ranges and extends the 2.5 volt range beyond 5.0 volts per division.

(3) INPUT IMPEDANCE. – 100 kilohms minimum, shunted by 30 $\mu\mu$f maximum (capacity typically less than 20 $\mu\mu$f).

b. SWEEP GENERATOR CHARACTERISTICS.

(1) SWEEP RANGE. – Adjustable in 19 calibrated steps in a 1, 2, 5, 10 sequence from 0.1 microsecond per division to 0.1 second per division, accurate to within 3 percent. The VARIABLE TIME/DIV control provides continuous adjustment of sweep timing between all ranges.

(2) SWEEP MAGNIFIER. – Sweep may be expanded five times with accuracy maintained within 3 percent for sweep speed of 0.1 μsec per division or slower.

(3) GATE OUTPUT. – Positive-going waveform coincident with the start of the sweep and lasting for the duration of the sweep. Output voltage is approximately 20 volts peak-to-peak.

c. TRIGGER CIRCUIT CHARACTERISTICS.

(1) TRIGGER SLOPE. – Line, internal, or external signal sources may be selected on either positive or negative polarity. Ac or Dc coupling may be selected for the EXT TRIGGER INPUT.

(2) TRIGGERING MODE. – The STABILITY control selects the operational state of the sweep generator. The STABILITY control may be set to TRIGGER, PRESET, or FREE RUN providing driven or recurrent operation of sweep.

(3) TRIGGER REQUIREMENTS.

(a) INTERNAL. – At least one-half division deflection on graticule.

(b) EXTERNAL. – At least 0.5 volt.

d. VERTICAL PLUG-IN MX-2996/USM-117 CHARACTERISTICS.

(1) BANDWIDTH. – Dc to 5 mc within 3 db, direct coupled; 2 cps to 5 mc within 3 db, capacity coupled.

(2) SENSITIVITY. – Adjustable in 11 calibrated steps in a 1, 2, 5, 10 sequence from 0.01 volt per division to 20 volts per division, accurate to within 5 percent. The VARIABLE VOLTS/DIV control provides continuous adjustment between ranges and extends the 20 VOLTS/DIV range to approximately 50 volts per division.

(3) INPUT IMPEDANCE. – 1 megohm shunted by 47 $\mu\mu$f maximum.

(4) INPUT ISOLATION. - 50 db minimum between INPUT A and INPUT B.

e. VERTICAL POST AMPLIFIER CHARACTERISTICS.

(1) BANDWIDTH. - In excess of 5 mc, within 3 db.

(2) SENSITIVITY. - Fixed at 0.1 volts peak-to-peak per division.

f. PROBE MX-2817/U.

(1) INPUT IMPEDANCE. - 1 megohm (±10 percent) shunted by 13 $\mu\mu$f maximum.

g. CALIBRATOR CHARACTERISTICS.

(1) WAVESHAPE. - Square wave of 1 kc (±10 percent) with rise and fall time of 1.5 μsec maximum.

(2) VOLTAGE AMPLITUDE. - Two calibrated voltages of 0.04 and 0.4 volt peak-to-peak, accurate to within 2 percent.

h. CATHODE-RAY TUBE CHARACTERISTICS.

(1) TYPE. - A 2-1/4 in. by 3-1/4 in. flat face, helical band, 3 kv post accelerator type 4QP crt with P2 phosphor screen.

(2) GRATICULE. - Edge illuminated type, 10 divisions long by 8 division high (1 division = 1/4 in.). Green filter, compatible with P2 phosphor, also supplied.

(3) DEFLECTION FACTORS.

(a) VERTICAL DEFLECTION PLATE (D3-D4) FACTOR. - Approximately 4.0 volts per division.

(b) HORIZONTAL DEFLECTION PLATE (D1-D2) FACTOR. - Approximately 6.8 volts per division.

(4) INTENSITY MODULATION. - Signal of plus 40 volts is required to blank the screen.

i. POWER REQUIREMENTS. - 115 volts ±10 percent, 50 - 60 cps ±5 percent or 400 cps ±10 percent. Power required is approximately 25 watts.

1-5. EQUIPMENT LISTS.

a. EQUIPMENT SUPPLIED. - Oscilloscope AN/USM-117 consists of the equipment listed in table 1-1.

b. SEMICONDUCTOR COMPLEMENT. - The semiconductor complement is given in table 1-2.

c. EQUIPMENT AND PUBLICATIONS REQUIRED BUT NOT SUPPLIED. - Refer to table 5-1 and paragraph 5-2 for equipment required but not supplied.

1-6. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. Department of the Army Pamphlet No. 310-4 is a current index of technical manuals, technical bulletins, supply manuals (types 7, 8, and 9), supply bulletins, lubrication orders, and modification work orders available through publication supply channels. The index lists the individual parts (-10, -20, -35P, etc) and the latest changes to and revisions of each equipment publication.

1-7. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting of errors, omissions, and recommendations for improving this equipment manual by the individual user is authorized and encouraged. DA Form 2028 will be used for reporting these improvements. This form may be completed by using pencil, pen, or typewriter. DA Form 2028 will be completed by the individual using the manual and forwarded direct to Commanding Officer, U. S. Army Electronics Command, ATTN: AMSEL-MR-NMP-AD, Fort Monmouth, New Jersey 07703.

TABLE 1-1. OSCILLOSCOPE AN/USM-117, EQUIPMENT SUPPLIED

QTY. PER EQUIP.	NOMENCLATURE		OVERALL DIMENSIONS *				
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH	VOLUME	WEIGHT
1	Oscilloscope Assembly	AN/USM-117	8-9/16	9-13/16	18-1/4	1,130	23
1	Oscilloscope	OS-106/USM-117	8-9/16	9-5/32	15-27/32	840	17
1	Vertical Plug-in	MX-2996/USM-117	4-13/16	3-1/8	9	92	2
2	Test Prod	MX-2817/U					
1	Oscilloscope Cover	CW-541/USM-117	7	9-13/16	4	245	4
1	Electrical Power Cable Assy	CX-4704/U	8 ft				
2	Radio Freq Cable Assy	CG-409E/U	8 ft				
2	Adapter Connector	UG-1035/U					
2	Adapter Connector	UG-255/U					
2	Adapter Connector	UG-273/U					
2	Adapter Connector	UG-274A/U					
2	Technical Manual						

*Note: Dimensions are in inches, volume in cubic inches, and weight in pounds. Dimensions include protrusions. Handle in resting position.

TABLE 1-2. OSCILLOSCOPE AN/USM-117, TRANSISTOR AND SEMICONDUCTOR COMPLEMENT

SECTION	NUMBER OF SEMICONDUCTORS OF TYPES INDICATED																									
	2N388	2N780	2N711	2N965	2N1225	2N337	2N1304	2N1226	2N706	2N338	2N1309	2N863	2N1307	2N1546	2N1305	2N547	1N643	1N751A	1N3031B	1N752A	1N756A	1N538	1N914	KX1140	KX1139	1N3051B	SZ540	Total
Low Voltage Power Supply														3	5			2	1	2	1	12						26
High Voltage Power Supply								2						1	1	2								2	1	1	4	11
Vertical Plug-in MX-2996/USM-117		2	4	1													2											9
Vertical Post Amplifier			4		5																							9
Horizontal Amplifier						1	1	2																				4
Sweep Trigger			2		2																							4
Sweep Generator			2		1				1	1	1	2	1				3			1								13
Calibrator		1					2																	2				5
Total Number of Each Type		1	2	12	1	8	1	3	4	1	1	1	2	1	4	6	2	5	2	1	3	1	12	2	1	1	4	84

Notes:
1. Crt is type 4QP-2
2. Substitute transistor type 2N705 for type 2N711 when making replacement.
3. Four SZ540 zener diodes may be replaced by three 1N989B and one 1N992B diodes per MIL-S-19500/117.

SECTION 2
INSTALLATION

2-1. UNPACKING AND HANDLING.

Care must be taken when unpacking and removing Oscilloscope AN/USM-117 from its shipping container. Refer to figure 2-1 for packing sequence. Dropping the instrument may affects its calibration, damage components, or cause the crt to crack or implode. To remove the instrument from its case, unlatch and remove the front cover; turn the fastener, located in the rear-center area of the case, one-quarter turn; slide the instrument forward. Once removed, check to see that the high voltage cap is firmly in place on the side of the crt. Likewise, check the deflection plate and geometry pin connections on the neck of the crt. Also note if the crt itself is firmly seated in its socket. When returned to its case and secured in place, the instrument is ready for use.

2-2. POWER REQUIREMENTS.

Oscilloscope AN/USM-117 is designed to operate from a power source of 115 volts ±10 percent, 50-60 cps ±5 percent or 400 cps ±10 percent, at 25 watts or more. It is important that Power Cable CX-4704/U be plugged into a properly grounded three connector power receptacle which matches the three prong polarized plug of the cable. If for any reason the third (ground) connector is removed from the plug or an adapter is used, the green (ground) wire on the plug must be connected to a suitable earth type ground.

WARNING

A shock hazard will result if the green (ground) lead is not properly grounded.

2-3. INSTALLATION REQUIREMENTS.

The amount of bench space required for convenient operation of Oscilloscope AN/USM-117 may be judged by referring to the outline drawing given in figure 2-2.

2-4. INSPECTION AND ADJUSTMENT.

After unpacking Oscilloscope AN/USM-117 from its shipping container and removing its case as described in paragraph 2-1, carefully inspect the instrument for physical damage. If the instrument is new or has just been repaired, it should be in calibration. If in doubt, make a preliminary amplitude check using the internal calibrator. Sweep time may be checked with a fair degree of accuracy by measuring the period of the calibrator waveform which is equal to one millisecond. More extensive checks along with complete calibrating instructions are given in section 6. The only external adjustments to be made are DC BAL and EF BAL on Vertical Plug-in MX-2996/USM-117. Refer to paragraph 3-3b for balancing adjustments.

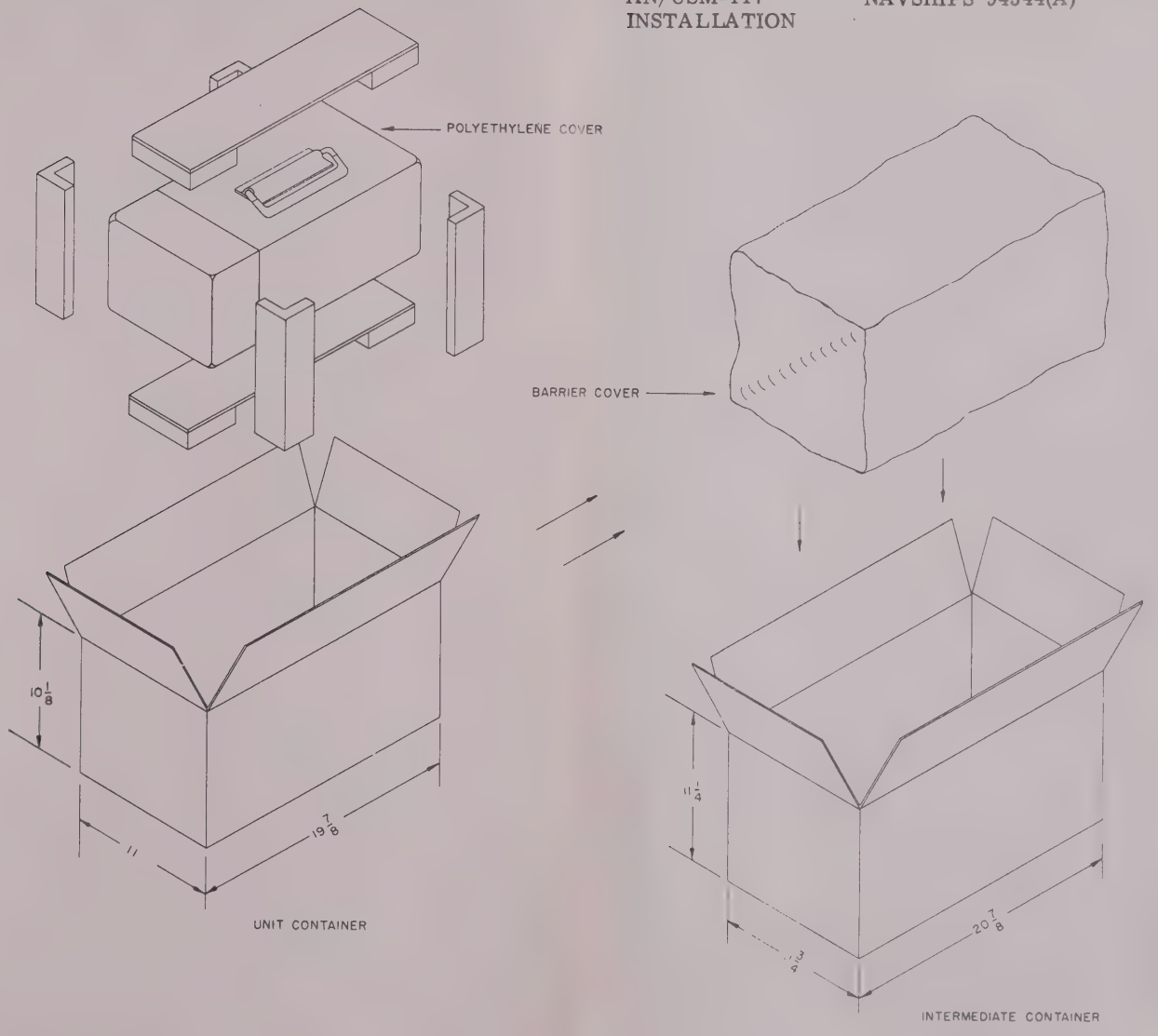


Figure 2-1. Oscilloscope AN/USM-117, Packing

Figure 2-2. Oscilloscope AN/USM-117, Outline Drawing

SECTION 3
OPERATOR'S SECTION

3-1. FUNCTIONAL OPERATION.

Although designed as a general purpose instrument, the compact size and light weight of Oscilloscope AN/USM-117 make it especially useful in field maintenance applications. A wide range of signal levels may readily be viewed using vertical plug-in MX-2996/USM-117 which has a basic sensitivity of 10 millivolts per division and a bandpass of five megacycles. Calibrated sweep time and vertical amplitude selectors permit accurate input signal measurements. Control of sweep circuit functioning provides for either triggered or free-running operation. Stability of operation is insured by the use of a regulated power supply.

3-2. PREPARATION FOR USE.

With the polarized line cord properly inserted into a power receptacle, turn the POWER switch to ON. Allow at least a five minute warm-up period. Never allow a bright undeflected spot to remain on the crt screen.

3-3. OPERATING PROCEDURES.

Since proper operation depends on correct interpretation and use of controls and connectors, the location, markings, and functions of these devices are described before the operating procedures are presented. Paragraph 3-4 offers a detailed explanation of typical operating procedures.

a. DESCRIPTION OF CONTROLS. — All controls required for normal operation are mounted on the front panel of Oscilloscope AN/USM-117. Figure 3-1 illustrates all front panel controls and connectors. The functions of the controls and connectors are described in table 3-1.

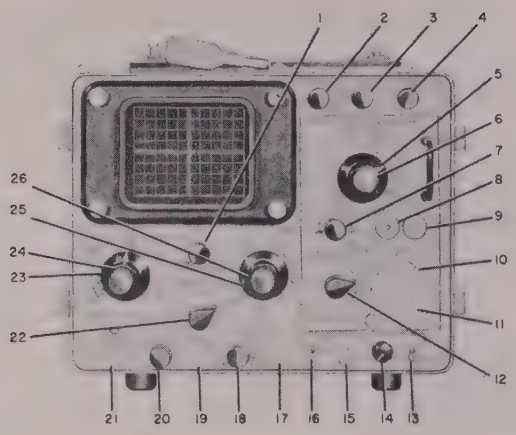


Figure 3-1. Oscilloscope AN/USM-117, Front Panel Controls

TABLE 3-1. OSCILLOSCOPE AN/USM-117, OPERATING CONTROLS AND CONNECTORS

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
POWER switch	13	Turns power on or off.
CATHODE RAY TUBE CONTROLS AND CONNECTOR		
INTENSITY control	2	Adjusts the degree of spot or trace brightness.
FOCUS control	3	Adjusts size and sharpness of spot on crt screen.

TABLE 3-1. OSCILLOSCOPE AN/USM-117, OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
CATHODE RAY TUBE CONTROLS AND CONNECTOR - Cont'd		
ASTIG control	4	Adjusts shape of spot on crt screen.
SCALE control	14	Adjusts illumination of lines on crt graticule.
Z-AXIS INPUT connector	21	Accepts signals for intensity modulation of crt.
VERTICAL PLUG-IN MX2996/USM-117 CONTROLS AND CONNECTORS		
VOLTS/DIV switch	5	Selects deflection sensitivity values from 0.01 volt to 20 volts peak-to-peak per division. Ac coupled only below 0.1 volt per division.
VARIABLE control	6	Concentric red knob with VOLTS/DIV switch provides uncalibrated variable sensitivity between steps on the VOLTS/DIV switch. Also extends sensitivity on 20 VOLTS/DIV range to 50 VOLTS/DIV.
POSITION control	7	Positions the trace on a vertical plane.

TABLE 3-1. OSCILLOSCOPE AN/USM-117, OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
INPUT SELECTOR switch	12	Selects either INPUT A or INPUT B with AC or DC coupling as desired.
VERTICAL PLUG-IN MX-2996/USM-117 CONTROLS AND CONNECTORS - Cont'd		
DC BAL control	8	Adjusts balance of vertical preamplifier, thereby preventing trace shift when the VARIABLE control is rotated.
EF BAL control	9	Adjusts input impedance of input stage to proper value, and prevents trace shift when the VOLTS/DIV switch is rotated.
INPUT A connector	10	Accepts signals fed to vertical preamplifier.
INPUT B connector	11	Accepts signals fed to vertical preamplifier.
HORIZONTAL CONTROLS AND CONNECTOR		
POSITION control	18	Positions the trace on a horizontal plane.
HORIZ MODE switch	22	Functions to attenuate external horizontal deflection waveforms on the X1, X2, and X5 positions. Also provides sweep and 5X MAG sweep.

TABLE 3-1. OSCILLOSCOPE AN/USM-117, OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
HORIZONTAL CONTROLS AND CONNECTOR - Cont'd		
HORIZ GAIN control	20	Adjusts uncalibrated variable sensitivity between X1, X2, and X5 ranges. Also extends sensitivity on X5 range beyond five volts per division.
HORIZ. INPUT connector	19	Accepts signals for horizontal deflection when the HORIZ MODE switch is set to X1, X2, or X5.
SWEEP AND TRIGGER CONTROLS AND CONNECTORS		
TIME/DIV switch	23	Selects sweep speeds in 19 calibrated steps in a 1, 2, 5, 10 sequence from 0.1 microsecond to 0.1 second per division.
VARIABLE control	24	Concentric red knob with TIME/DIV switch provides adjustment between steps on TIME/DIV switch. When turned from the maximum cw position, the sweep is uncalibrated.

TABLE 3-1. OSCILLOSCOPE AN/USM-117, OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
SWEEP AND TRIGGER CONTROLS AND CONNECTORS - Cont'd		
STABILITY control	1	Adjusts the time base generator for TRIGGER (driven) operation or FREE RUN (recurrent) operation. PRESET position provides optimum triggering point as determined by an internal stability control.
TRIGGER SLOPE switch	25	Selects the type of triggering signal: LINE, INT, and EXT on either + or − slope. AC or DC coupling may be selected on EXT TRIGGER.
LEVEL control	26	Concentric red knob with TRIGGER SLOPE switch determines the level on the amplitude of the triggering waveform for the start of the sweep.
EXT TRIGGER INPUT connector	17	Accepts signals to trigger the sweep when the TRIGGER SLOPE switch is set to any position on the right hand side of its dial.
GATE OUT connector*		Provides a positive-going waveform coincident with the start of the sweep and lasting for the duration of the sweep.

TABLE 3-1. OSCILLOSCOPE AN/USM-117, OPERATING CONTROLS AND CONNECTORS (Continued)

CONTROL MARKING	ITEM NO., FIG. 3-1	FUNCTION
CALIBRATOR CONTROL AND CONNECTOR		
CALIBRATOR switch	16	Selects accurate square wave of either 0.04 or 0.4 volt peak-to-peak. Output waveform is available at front panel jack.
CALIBRATOR OUTPUT connector	15	Provides accurate square wave of either 0.04 or 0.4 volt peak-to-peak as determined by the setting of the CALIBRATOR switch.

*NOTE: Located in top-rear area of instrument below access cover.

b. BALANCING ADJUSTMENTS. – Two initial adjustments are required for proper balance when using Vertical Plug-in MX-2996/USM-117. These adjustments prevent trace shift when the VOLTS/DIV switch and VARIABLE control are rotated. With no signal applied and the STABILITY control set to FREE RUN, rotate the VOLTS/DIV switch back and forth between the 0.1 and 0.2 positions. If any vertical deflection of the trace is noted on screen, adjust the EF BAL control until such deflection has ceased. Next, set the VOLTS/DIV switch to the 0.1 position and vary the VARIABLE control back and forth over its entire range. If any vertical deflection of the trace is noted on screen, adjust the DC BAL control until such deflection has ceased. Repeat procedure for finer adjustment. Use 0.1 in. blade width screwdriver for this adjustment.

c. AC-DC COUPLING. – Many applications permit the use of ac coupling. The dc level of the signal (if any) will be lost, and frequencies below 2 cps will be sharply attenuated. These conditions, however, may be of little consequence, making ac coupling most desirable. Note that ac coupling is a "must" when viewing small signals having a high dc component. For example, observing the ripple signal riding on the high dc level of the power supply output. Remember that the coupling on all ranges below 0.1 VOLTS/DIV of Vertical Plug-in MX-2996/USM-117 is AC ONLY.

d. SWEEP STABILITY SETTING. – Use of the PRESET position of the STABILITY control provides the best triggering in most all general test applications. Advancing this control into the area marked TRIGGER affords manual operation for the triggering state of the sweep. Advancing the control still farther, into the FREE RUN area, causes the sweep circuit to oscillate at a rate relative to the setting of the TIME/DIV switch. Repetitive signals may be synchronized in the free-running state. However, most test applications require triggered operation which is provided for by the PRESET or TRIGGER positions of the STABILITY control.

e. TRIGGER LEVEL SETTING. – Once the sweep is in a triggered state, its starting point, relative to the applied triggering signal, may be established by the setting of the trigger LEVEL control. For example, if a sine wave is being viewed, rotating the LEVEL control would cause the slope of the waveform to slide up and down at the starting point of the trace.

Large trigger signals (25 volts and up) require a wide range of rotation on this control. Trigger signals having a small amplitude may require only a few degrees rotation to traverse the entire slope of the waveform.

f. APPLYING EXTERNAL HORIZONTAL SIGNALS. – Application of external horizontal deflection waveforms may be made to the HORIZ INPUT connector on the front panel. Such signals may be used to (1) substitute for the internal time base, (2) display Lissajous (X vs Y) figures at frequencies below the roll off characteristic of the horizontal bandwidth, and (3) perform other tests requiring special X axis input signals. Paragraph 3-4e gives further details regarding application of external horizontal deflection signals.

g. INTENSITY MODULATION. – External signals such as time-mark pulses may be coupled through the Z AXIS INPUT connector on the front panel to the crt cathode for intensifying or blanking the beam. The coupling time constant is 0.22 millisecond. Positive-going signals blank the beam; negative-going signals intensify the beam. About 40 to 50 volts peak-to-peak of signal is required for good intensity modulation with high light output of the crt.

h. HIGH IMPEDANCE PROBES. – Two Test Prods MX-2817/U are supplied with each Oscilloscope AN/USM-117. When loading effects of the normal vertical input impedance are considered detrimental, a probe should be used. Using the probe affords ten times the normal one megohm input resistance and a much lower shunt capacity 13 $\mu\mu$f max). Sensitivity figures read from the VOLTS/DIV switch dial should be multiplied by 10 when the probe is used. For example, 0.1 VOLTS/DIV would become 1.0 VOLTS/DIV.

Frequency compensation of the probe should be checked before use. The 0.4 volt square wave output of the CALIBRATOR may be used for this check. Set the VOLTS/DIV switch to 0.01 and the TIME/DIV switch to 0.2 MILLISEC. Touch the tip of the probe to the CALIBRATOR OUTPUT connector. Adjust the STABILITY and LEVEL controls to obtain a stable waveform pattern. Back off on the locking ring at the rear section of the probe and rotate the disc like adjustment which was held tight by the locking ring. Adjust the probe for optimum square wave response: no overshoot or undershoot. Tighten the locking ring to hold this adjustment. The probe is now properly compensated.

3-4. SUMMARY OF OPERATING PROCEDURE.

a. GENERAL. – Details of typical operating procedures, as related to Oscilloscope AN/USM-117, are listed in the following paragraphs. Observe all applicable directions given in paragraphs 3-2 and 3-3. Required cable connections may be made with cable assemblies supplied as accessories with the equipment, or with shorter length cables if desired.

b. INTERNAL SWEEP WITH INTERNAL TRIGGERING.

(1) Apply a vertical input signal to INPUT A connector on plug-in.

(2) Set the INPUT SELECTOR switch to INPUT A-DC, or INPUT A-AC if ac coupling is desired.

(3) Set the VOLTS/DIV switch for desired sensitivity. Turn the VARIABLE VOLTS/DIV control to CAL position (maximum clockwise).

(4) Set the TRIGGER SLOPE switch for +INT or –INT triggering, depending upon polarity desired.

(5) Select desired sweep speed with the TIME/DIV switch. Turn the VARIABLE TIME/DIV control to CAL position (maximum clockwise).

(6) Set the HORIZ MODE switch to SWEEP.

NOTE

In most general test applications, the STABILITY control may be set at PRESET in step (7).

(7) Rotate the STABILITY control counterclockwise until sweep stops; advance this control slightly clockwise until most stable waveform presentation is obtained.

(8) Rotate the trigger LEVEL control to zero; then adjust slowly to select some point on the amplitude of the waveform for the start of the sweep.

c. INTERNAL SWEEP WITH EXTERNAL TRIGGERING.

(1) Apply a vertical input signal to INPUT A connector on plug-in.

(2) Set the INPUT SELECTOR switch to INPUT A-DC, or INPUT A-AC if ac coupling is desired.

(3) Set the VOLTS/DIV switch for desired sensitivity. Turn the VARIABLE VOLTS/DIV control to CAL position (maximum clockwise).

(4) Apply an external trigger signal to the EXT TRIGGER INPUT connector.

(5) Select +DC, −DC, +AC, or −AC external triggering, depending upon the polarity and coupling desired.

(6) Select desired sweep speed with the TIME/DIV switch. Turn the VARIABLE TIME/DIV control to CAL position (maximum clockwise).

(7) Set the HORIZ MODE switch to SWEEP.

NOTE

In most general test applications, the STABILITY control may be set at PRESET in step (8).

(8) Rotate the STABILITY control counterclockwise until sweep stops; advance this control slightly clockwise until most stable waveform presentation is obtained.

(9) Rotate the trigger LEVEL control to zero; then adjust slowly to select some point on the amplitude of the waveform for the start of the sweep.

d. MAGNIFIED SWEEP.

(1) Set the HORIZ MODE switch to SWEEP.

(2) Select desired sweep speed with the TIME/DIV switch. Turn the VARIABLE TIME/DIV control to CAL position (maximum clockwise).

(3) Adjust the horizontal POSITION control until that portion of the waveshape which is to be magnified coincides with the center vertical line on the graticule.

NOTE

Refer to reference data listed in paragraph 1-4 for limit of magnification.

(4) Set the HORIZ MODE switch to 5X MAG. Sweep expands from center, and sweep calibration is equal to TIME/DIV setting divided by five.

e. EXTERNAL HORIZONTAL INPUT.

(1) Apply external horizontal deflection signal to the HORIZ INPUT connector.

(2) Turn the STABILITY control fully counterclockwise to PRESET position.

(3) Adjust the horizontal POSITION control as desired.

(4) Advance the INTENSITY control for desired brightness.

(5) Set HORIZ MODE switch to X1, X2, or X5, depending upon degree of horizontal deflection sensitivity desired.

f. CONNECTION TO DEFLECTION PLATES - EXTERNAL SIGNALS.

(1) Turn the POWER switch to OFF and remove access cover.

(2) Disconnect deflection leads from crt pin terminals.

(3) Connect external circuitry illustrated in figure 3-2 to either set of deflection plates.

(4) Position trace on horizontal or vertical plane using regular front panel controls (these controls remain active when circuitry shown in figure 3-2 is used).

3-5. OPERATOR'S MAINTENANCE.

a. OPERATING CHECKS AND ADJUSTMENTS. - No special operating checks need be performed by the operator. However, balance of Vertical Plug-in MX-2996/USM-117 should be checked periodically. Refer to paragraph 3-3b for the adjustment procedure.

b. REPLACEMENT OF PARTS. – When necessary, fuses may be replaced by operating personnel. Fuses F201 and F202 are located just below the access cover in the rear of the instrument. Two spare fuses are housed in a dual clip-type fuse holder on the inside rear chassis wall on the left hand side of the instrument. Fuse failure is indicated when the instrument is completely inoperative with the absence of illumination in the pilot light.

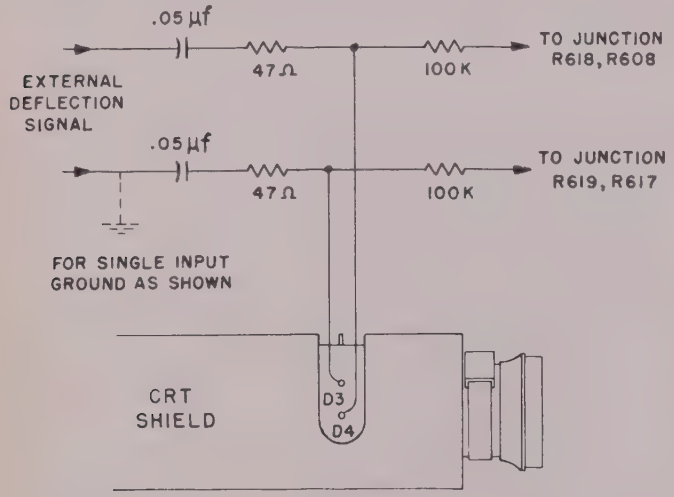


Figure 3-2. Oscilloscope AN/USM-117, External Connection to Cathode Ray Tube

SECTION 4
PRINCIPLES OF OPERATION

4-1. OVERALL FUNCTIONAL DESCRIPTION.

Figure 4-1 illustrates the block diagram of Oscilloscope AN/USM-117, including principal waveforms. The function of each section is discussed in the following paragraphs. A more detailed analysis of individual circuit action is covered by the group of paragraphs beginning with paragraph 4-2.

a. LOW VOLTAGE POWER SUPPLY. — The low voltage power supply section of Oscilloscope AN/USM-117 provides regulated dc for all circuitry throughout the instrument, and is designed to operate on 115 volts at 50, 60, or 400 cycles. Five regulated voltage sources are employed: +20 volts, +5 volts, -5 volts, -15 volts, and -55 volts.

b. VERTICAL CHANNEL. — The vertical channel may be divided into two distinct parts: Vertical plug-in MX-2996/USM-117 and the post amplifier, an integral part of Indicator OS 106/USM-117. The plug-in type preamplifier consists of an A or B input selector, compensated input attenuator, and a balanced amplifier stage with emitter follower outputs to drive the post amplifier. Vertical positioning is accomplished in the preamplifier Output signals from the preamplifier enter the post amplifier through interconnecting plug J803. Signals presented to the post amplifier are further amplified and then delayed before being applied to the vertical deflection plates. Signal delay insures that the sweep has started before the signal itself is presented on the time base.

c. HORIZONTAL CHANNEL. — External deflection signals applied to the horizontal amplifier pass through a three step compensated input attenuator. Internal sweep is applied directly to an emitter follower stage at the input of the horizontal amplifier. HORIZ MODE switch S401 selects either external or internal (sweep) signals. When the amplifier is driven by some external signal the HORIZ GAIN control is made active through S401 switching, and may be used for continuous adjustment between the X1, X2, and X5 ranges. Magnification of the sweep is accomplished by increasing the sensitivity of the output amplifier by a factor of five.

d. HIGH VOLTAGE SUPPLY AND CRT. — High voltage for the type 4QP crt is furnished by a regulated high voltage supply. The oscillator stage of the dc to dc converter generates a signal which is stepped up by action of high voltage transformer T301. It is then rectified, filtered, and fed to the crt. The cathode ray tube is a helical band post-accelerator type having an overall accelerating potential of 3 kilovolts. Shunt capacity effects are minimized by having the deflection plate terminals located on the neck of the tube rather than the base. A Z AXIS INPUT connector for external intensity modulation of the crt beam is also incorporated.

e. TRIGGERING STAGES. — Triggering stages consist of a trigger amplifier and Schmitt trigger circuit. Internal, external (ac or dc), or line triggering signals are selected by TRIGGER SLOPE switch S501 and applied to the trigger amplifier which provides amplification and, if desired, polarity inversion. The Schmitt trigger circuit develops a sharp positive-going spike, coincident with the trigger input waveform which is used to actuate the sweep generator.

f. SWEEP GENERATOR. — A time base display is provided by a sawtooth waveform produced by the sweep generator. TIME/DIV switch S702 selects the desired sweep speed and the STABILITY control selects the operational state of the sweep generator. Normally this circuit is operated in a triggered state with the aid of pulses supplied by the triggering stages.

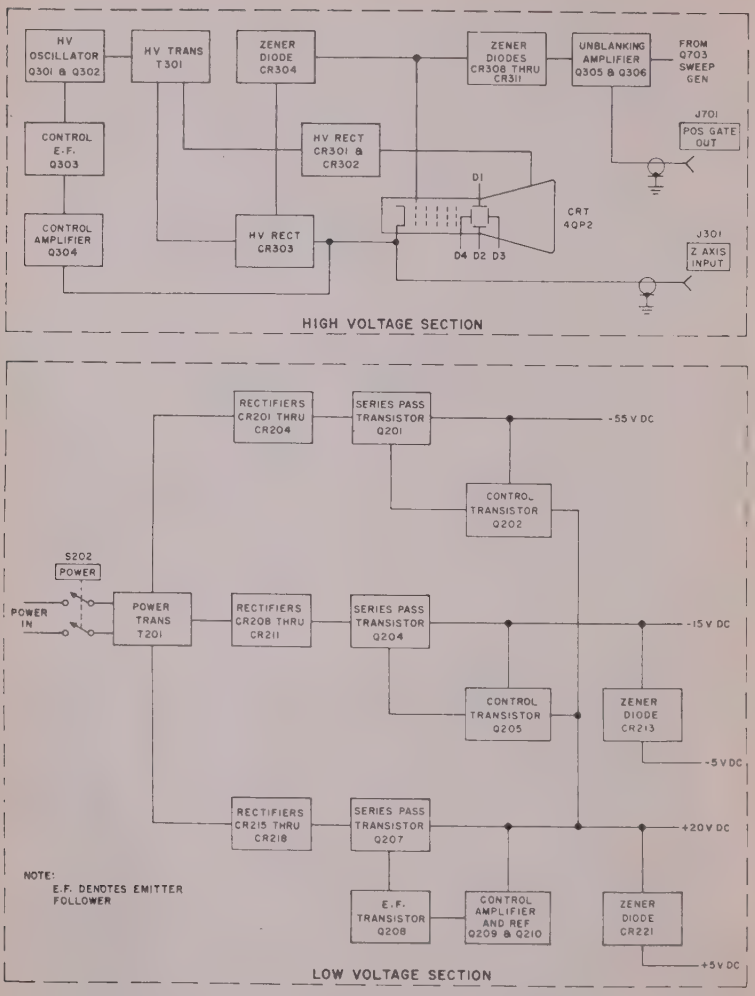


Figure 4-1. Oscilloscope AN/USM-117, Block Diagram (Sheet 1 of 2)

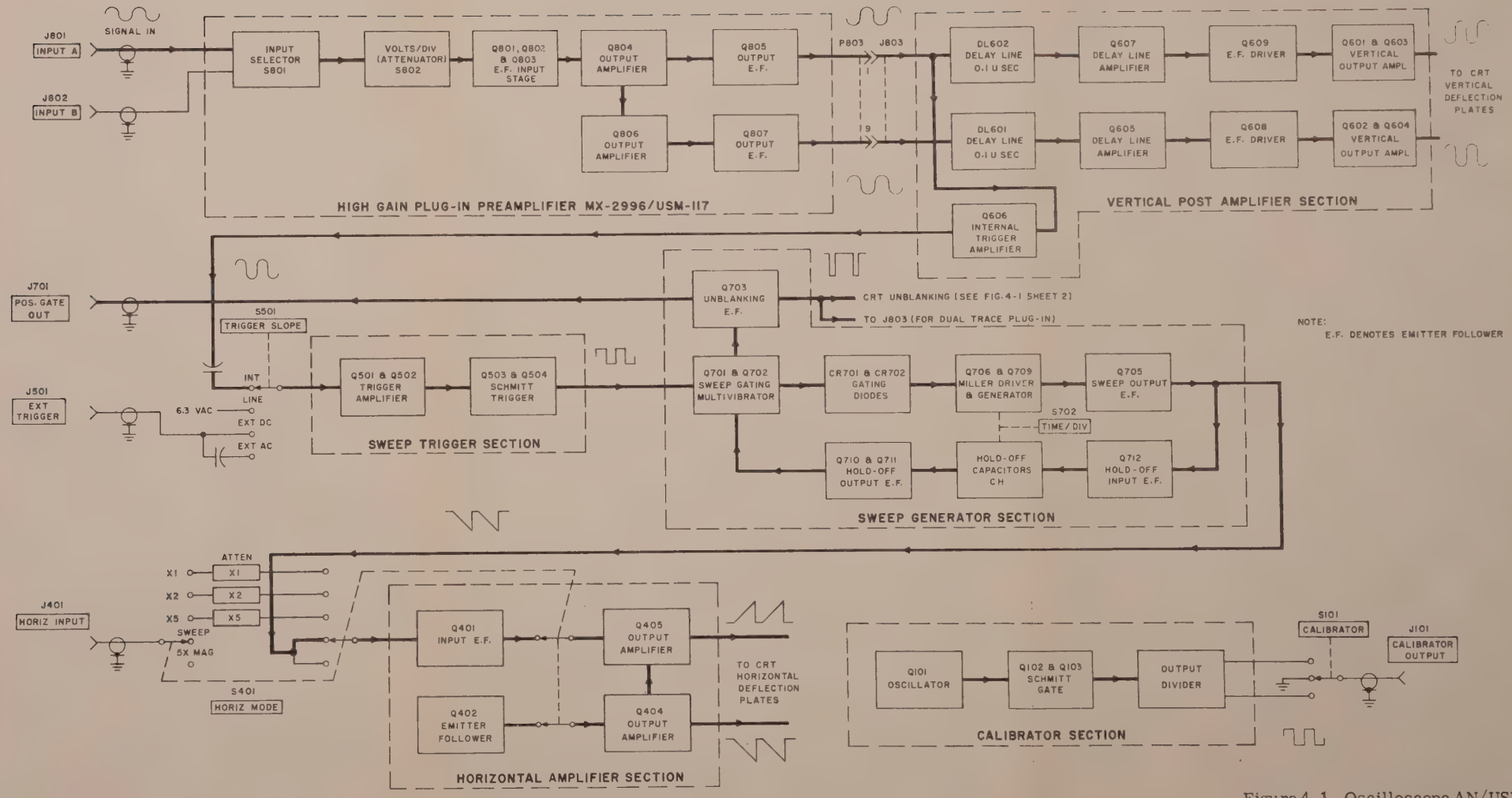


Figure 4-1. Oscilloscope AN/USM-117, Block Diagram (Sheet 2 of 2)

Advancing the STABILITY control in a clockwise direction causes the circuit to function in a free-running state. It is also possible to synchronize the free-running sweep generator with repetitive trigger pulses. An unblanking waveform is taken from the sweep generator circuitry to intensify the beam when tracing, and blank it when retracing. A positive-going gate waveform, used to synchronize external equipment, is also derived from the sweep generator.

g. CALIBRATOR. — CALIBRATOR switch S101 selects one of two accurate amplitude square wave outputs: 0.4 or 0.04 volt peak-to-peak. A Schmitt trigger circuit, similar to the one used in the sweep triggering stage is used to square off and improve the slopes of the sine wave fed to it. The sine wave is produced by a Colpitts type oscillator.

4-2. FUNCTIONAL SECTIONS.

a. LOW VOLTAGE POWER SUPPLY. — Although five regulated voltage sources are provided, only three series regulated supplies are employed in this instrument. The two remaining sources are obtained by means of zener diode voltage drops (across CR213 and CR221) in the output of two series regulated supplies. One unregulated source of minus 38 volts is picked off at the input to pass transistor Q204 in the minus 15-volt series regulated supply. Each series regulated supply is fed by an individual secondary winding on power transformer T201. Each winding drives a full-wave bridge rectifier circuit using four identical silicon diodes. The plus 20-volt supply serves as a reference for the other two series regulated supplies. Since all three supplies operate in essentially the same manner, it is only necessary to consider one in the circuit analysis. A discussion of the minus 15-volt supply follows.

Output of the minus 15-volt supply is developed across the voltage divider consisting of R214, R217, R215, and R216. The bottom side of this divider is returned to the plus 20-volt reference supply. Load current flows through pass transistor Q204. Any variation in output voltage across the load is sensed as a bias change at the base of control transistor Q205. The

resulting change in the collector current through the collector load (R213) of Q205 is applied to the base of pass transistor Q204 as a change in bias. Depending upon the nature of the original voltage variation across the load, the effective series resistance from collector to emitter of Q204 increases or decreases to regulate the flow of load current, thereby maintaining the output voltage virtually constant. Zener diode CR212 in the emitter circuit of Q204 establishes a reference so that the only possible change in bias in its emitter to collector circuit is the change caused by a load voltage variation in the minus 15-volt supply. Potentiometer R215 permits adjustment of the supply output to exactly minus 15 volts. Capacitor C208 couples ripple voltage and more rapid voltage changes seen at the output back to the base of Q205.

R217 is a sensistor; its resistance increases with an increase in temperature. Since the minus 15-volt supply tended to decrease its output voltage (a positive-going change) by a half volt or so at higher temperatures, R217 was added to the circuit to correct this effect. As temperature increases, the combined value of R214 and R217 increases in resistance. Accordingly, the base of Q205 is driven more positive by a small degree. Considering the direction or polarity of change, the sequence is as follows: the base of Q205 becomes positive-going; the collector of Q205 and base of Q204 become negative-going; and the emitter of Q204 becomes negative-going toward the original minus 15 volts. Another sensistor, R207, is included in the minus 55-volt supply. Note that it is added in series with the voltage divider in this case, since this supply tended to increase its output voltage with an increase in temperature.

b. VERTICAL PLUG-IN MX-2996/USM-117. — Input signals enter the vertical plug-in through A or B INPUT SELECTOR switch S801. Either input A or B may be selected along with direct or capacitive coupling of the applied information. Large signals are reduced in amplitude by means of VOLTS/DIV switch S802 which employs five frequency compensated attenuator networks. The attenuator networks are used separately or in cascade depending upon the setting of the VOLTS/DIV switch. The most sensitive range, 0.01 VOLTS/DIV, affords no attenuation since it couples the signal straight through. The variable

capacitor bridged across the resistor in the top leg of each attenuator network passes higher frequencies which would normally be lost due to the preamplifier's input capacity. For optimum frequency response, these variable R-C sections are adjusted to equal the R-C product or time constant of the input circuit.

The signal at the output of the attenuator is impressed at the base of input emitter follower Q801 through a frequency compensated series resistor, R815. CR801 and CR802 are clamping diodes used to protect Q801 by preventing the applied level of voltage at its base from exceeding plus or minus five volts. Adjustment of EF BAL control R818 for zero potential at the junction of R816 and R817 prohibits dc current flow in the input signal path. The total or combined resistance looking into the base circuit of Q801 from the attenuator side of R815 is one megohm. Two additional emitter followers, Q802 and Q803, lower the driving impedance of the signal source. From here the signal is coupled into Q804, one side of the push-pull output amplifier. Transistors Q804 and Q806 are connected as an emitter-coupled phase inverter, thus offering a balanced or push-pull type output signal. DC BAL control R825, in conjunction with R827 and R828, sets the level at the base of Q806. This control is adjusted so that zero dc potential exists across VARIABLE control R831, thus preventing trace shift when this control is rotated. Calibrated sensitivity is established in the emitter circuit of this stage by having .01V ADJ control R829 set the amount of emitter degeneration. C820 is adjustable to provide the proper degree of emitter peaking when the VARIABLE control is in its full clockwise or CAL position. Similar frequency compensation is provided by C822 when the VARIABLE control is rotated counterclockwise.

Emitter follower pair Q805 and Q807 offer a low impedance driving source for the post amplifier. Rotating POSITION control R838 from its midpoint causes the bias at the base of one output emitter follower to increase and the other to decrease. Resistors R837 and R839 have been chosen to set the required range of positioning.

c. VERTICAL POST AMPLIFIER. — After entering the vertical post amplifier, one phase of the output signal from the preamplifier is applied to the internal trigger amplifier. Internal trigger information is fed to the base of Q606 from the compensated voltage divider network consisting of R601, R602, and C601. The output of Q606 is passed on to the trigger amplifier through TRIGGER SLOPE switch S501. Both signal phases enter the balanced delay line arrangement. These delay lines, DL601 and DL602, are matched to their characteristic impedance at the input and output. The matching resistors also serve as emitter loads for Q805 and Q807 in the preamplifier. The delay lines employed here are the distributed constant type having a bandwidth several times that of the vertical channel. Transistors Q605 and Q607 act as a balanced or push-pull amplifier which restores the two times gain loss effected by the terminated delay lines. The emitter follower driver stages consisting of Q608 and Q609 provide light loading for the output of the delay line amplifier and a low impedance driving source for the vertical output amplifier

Since relatively large signal swings fed from a low impedance source are required to drive the vertical deflection plates, a special circuit configuration is used for the vertical output amplifier. Stacking two transistors in series to share the total signal swing solves this problem. In this way, the swing across either transistor will not exceed its rated maximum collector voltage. Consider only one side of the circuit which is identical to the opposite side: R608 and R609 is a divider network which establishes the proper bias level at the base of Q603. The bias source is taken at the bottom side of output load resistor R618, thus providing degenerative feedback to improve the distortion figure. Adjustment of GAIN ADJ control R612 calibrates the sensitivity of the post amplifier by affecting the amount of emitter degeneration. C605 and C605A act as peaking capacitors which provide frequency compensation for a given setting of R612.

d. HORIZONTAL AMPLIFIER. — Input emitter follower Q401 accepts either external deflection signals or internal sweep through the switching of S401. Adjustment of ZERO SET control R408 for zero potential at the junction of R410 and R411 prohibits dc current flow in the input signal path. Sweep signals from the output of Q401 drive Q405, one half of the push-pull output stage. External deflection signals from the output of Q401 drive Q404, the opposite half of the push-pull output stage. This arrangement, brought about by S401 switching, is necessary in order that positive-going external signals deflect the beam from left to right, while the time-base also traces from left to right. Transistors Q404 and Q405 function as an emitter-coupled phase inverter. Emitter follower Q402 sets the quiescent level at the base of the output stage transistor which is not driven by the signal source. Since the bias at the base of Q402 may be varied by adjustment of horizontal POSITION control R421, the collector to collector level of the output stage may be caused to shift, offering positioning on the horizontal plane.

Horizontal sweep and times five sweep calibration are established by a given amount of emitter degeneration in the output stage. The common emitter resistor in this stage, labeled BIAS ADJ R435, determines the optimum operating point for the applied signal. The output amplifier employs shunt peaking in the form of L401 and L402 to extend its high frequency response.

e. HIGH VOLTAGE POWER SUPPLY. — The oscillator section of the dc to dc high voltage converter consists of two transistors, Q301 and Q302, in a balanced, over-driven, transformer coupled circuit. Collector to base feedback through transformer T301 allows each transistor to operate alternately in a nonconducting and saturated current state. Frequency of operation is about 1.5 kilocycles. Maximum stepped up secondary voltage of the transformer is fed to a conventional voltage doubler circuit consisting of C302, C303, and two high voltage diode rectifiers, CR301 and CR302. This positive polarity 2400-volt source supplies the high voltage anode of the crt. A lower voltage tapped off in the secondary of the transformer is fed to a half wave rectifier circuit and L-C type filter network. The diode

rectifier in this circuit, CR303, is connected to obtain negative polarity output. Zener diode CR304 drops the output of this supply to minus 580-volts which is applied to the cathode of the crt.

The regulator circuit samples the output of the minus 580-volt source for any error. The error signal, if any, is fed to a direct coupled amplifier which controls the signal output level of the oscillator stage. Q304 functions as the direct coupled amplifier, and Q303 is connected as an emitter follower which sets the level of the collector supply for Q301 and Q302. This controlled supply attempts to maintain the output of the minus 580-volt supply constant as the error signal changes. Since the error signal amplifier controls the oscillator stage, adjustment of HV ADJ control R311 causes a change in voltage output of the minus 580-volt supply.

Unblanking for the crt is applied at the top of the voltage divider network consisting of R319, R320, R321, and R322. INTENSITY control R321 sets the dc voltage level at the control grid of the crt. The unblanking waveform is coupled to the crt control grid through a series of four zener diodes. Since these diodes provide a low impedance signal path, no loss in unblanking waveform amplitude is brought about by the voltage divider. Capacitor C314 insures that the leading edge of the unblanking waveform is passed on to the control grid without being degraded.

f. TRIGGER CIRCUITS. — Signals from any of the three trigger sources are applied to the base of Q501 or Q502, depending upon the setting of TRIGGER SLOPE switch S501. The base which does not receive signal is returned to an adjustable bias source controlled by LEVEL control R505. Circuit arrangement shows a combined emitter follower, Q501, and amplifier, Q502, which share the common emitter resistor, R508. Consider circuit action with switch S501 set to a positive slope position: a positive-going input signal is fed to emitter follower Q501 which drives Q502, acting as a grounded base amplifier. Therefore, the signal at the collector of Q502 is positive-going, since no phase reversal takes place in a grounded base stage. Under these conditions, the sweep starts on the positive slope of the triggering signal. With switch S501 set to a negative slope

position, the positive-going input signal is fed directly to the base of Q502, acting as a conventional amplifier. The resulting phase reversal causes a negative-going signal to appear at the collector of Q502. Accordingly, the sweep will not start until one half cycle later (on the negative slope of the trigger signal), when the signal at the collector of Q502 is positive-going.

Output signals from Q502 are directly coupled to the input of the Schmitt trigger circuit consisting of Q503 and Q504. Amplified trigger signals applied to the base of Q503 vary about the quiescent level of the collector of Q502. This level, adjustable by means of the LEVEL control, determines the operational state of the Schmitt trigger circuit. When the sweep generator is dormant, Q503 is conducting and Q504 is cut off. A positive-going signal appearing at the collector of Q502 drives Q503 toward cutoff. Note that Q503 and Q504 are PNP type transistors operating from a negative collector supply. Therefore, positive-going signals drive them toward cutoff and negative-going signals drive them toward conduction. As the current through Q503 decreases, its collector swings negative. This negative-going collector voltage is directly coupled to Q504 through the voltage divider R515 and R516. When the base of Q504 is driven negative, it starts to conduct. The resulting current through common emitter resistor R512 reinforces cutoff action on Q503, thus increasing the negative-going signal fed to the base of Q504 from the collector of Q503. This chain of events causes the Schmitt trigger circuit to transfer to its other state: Q503 cutoff and Q504 conducting. Only a fraction of a microsecond is required to complete this transition. During this transition, a fast rise time positive-going step voltage appears at the collector of Q504. The step waveform is differentiated, and the resulting positive spike is used to actuate the sweep generator.

g. SWEEP GENERATOR. — Four principal circuits are incorporated in the sweep generator: the gating multivibrator, Miller circuit, hold-off circuit, and the unblanking/gate out circuit (the latter circuit is physically located in the high voltage section). Positive spikes from the Schmitt trigger circuit are coupled to the base of Q701 in the gating multivibrator.

When Q701 is waiting to receive a trigger pulse (no sweep on crt), it is conducting and Q702 is cutoff. Advancing STABILITY control R725 in a clockwise direction causes the base of Q701 to swing in a positive direction. A point is reached, near mid rotation on the control, where the positive spikes from the Schmitt-trigger circuit are of sufficient amplitude to cause Q701 to swing toward cutoff. Note that Q701 and Q702, like Q503 and Q504, are PNP type transistors; they require negative levels for conduction and positive levels for cutoff. As the collector voltage of Q701 decreases, it causes the base of Q702 to be driven in a negative direction, the change being coupled through by R703 and R706. Current starts to flow in Q702. Current flow, due to the conduction of Q702, causes the voltage drop across R705 to swing in a negative direction. Since this voltage controls the bias of Q701, it lowers the current flow through Q701, further dropping its collector voltage. The effect is cumulative, terminating with Q701 cutoff and Q702 conducting.

When Q702 conducts, its collector generates a positive-going step which back-biases gating diodes CR701 and CR702. These open circuited diodes no longer shunt sweep timing capacitor Ct, thus permitting the base of the Miller driver Q706, connected as a modified emitter follower, to swing positive. Note that the output of Q706 is taken from the emitter with a high frequency feedback network connected in its collector to base circuit. As the base of Q706 swings positive, its emitter which is direct coupled to the base of Q709, likewise swings positive. The collector of the Miller transistor, Q709, is negative-going. This negative-going signal swing is direct coupled to the base of emitter follower Q705 through zener diode CR703. The output signal of Q705 is negative-going. Notice that this voltage swing opposes the input voltage swing seen at the base of Q706. Degenerative action restricts the swing in signal at the base of Q706 and causes the negative-going sawtooth slope being generated at the collector of the Miller transistor to decline in a highly linear manner.

When the sawtooth reaches a predetermined amplitude, as set by SWP LGTH control R734, Q701 is forced into cutoff by action of the hold-off circuit. This, in turn, causes retrace of the sawtooth waveform. Hold-off insures that the sweep circuits

will have enough time to return to their initial state before they are triggered for the next sweep cycle. The negative-going sawtooth waveform applied to the base of hold-off emitter follower Q712 is also present at its emitter in the same phase. Hold-off capacitor Ch is driven by Q712, as is the double emitter follower stage (Q710 and Q711) which isolates Ch from the trigger and sweep gating circuits. During active sweep time, Q701 is cutoff but the negative-going sawtooth applied to its base from the emitter of Q710 will force it into conduction at a given point on the negative slope. When Q701 conducts, Q702 shuts off. The resulting negative step at the collector of Q702 forward-biases CR701 and CR702, discharging the timing-capacitor and causes the sweep to retrace. Capacitor Ch in the hold-off circuit attempts to follow the positive-going retrace, but the time constant of the circuit is relatively long (Q712 is not a low impedance emitter follower) so that Q701 is held in conduction for a finite period of time after retrace. This period is referred to as hold-off time.

Unblanking for the displayed time base and the positive gate output for external use are derived from the sweep gating multivibrator. When the crt beam is tracing, Q701 is cutoff producing a negative step voltage (coincident with the start of the sweep). This waveshape is applied to the base of emitter follower driver Q713. The unblanking amplifier, Q305, is driven by Q713. Emitter follower Q306 provides a low impedance driving source for the amplified and inverted signal appearing at the collector of Q305. Resistors R325 and R326 make up the total emitter resistor for Q306, with C315 serving as high frequency compensation for the positive gate output.

h. CALIBRATOR. — The calibrator may be divided into three distinct circuits: a Colpitts oscillator, Schmitt trigger, and precision voltage divider with associated diode clamps. Output from the 1000 cps sine wave generator is taken from the split tank capacitor junction (tank to emitter feedback point). This output signal is fed to the input of the Schmitt trigger circuit consisting of Q102 and Q103. Circuit action is similar to that of the trigger circuit described in paragraph 4-2f, except for the type of transistors used; Q102 and Q103 are NPN rather than

PNP type. However, the end result is the same: a fast rise time, rectangular output signal. Total swing of this signal as seen at the collector of Q103 is about 8 volts peak-to-peak. Since the quiescent level at this point is approximately zero, CR101 will remove all signal swing below this level. CAL ADJ control R112 is adjustable to obtain an accurate 0.4-volt peak-to-peak swing at the top of R114. The signal appearing across R115 is exactly one-tenth this value or 0.04 volt peak-to-peak. Diode CR102 insures low impedance clamping to ground level and removes any undershoots which may tend to appear in the output waveform.

SECTION 5
TROUBLESHOOTING

5-1. GENERAL.

Successful troubleshooting depends to a great extent upon the ability of the technician to localize the trouble. Finding the component or components at fault, once the trouble area has been isolated, is a matter of routine in most instances. Troubles can often be related to a particular functional section simply by the way the trouble manifests itself on the crt presentation. Further localization can be effected by making use of the illustrated waveforms on the schematic diagrams and the voltage-resistance tabular data found in section 5. When a particular transistor or component is suspected, it is best to replace it with one which is known to be good.

The troubleshooting procedures listed herein are of a general nature, covering the more common problems likely to be found. More specialized procedures related to less common problems may be readily formulated after a careful study of the circuit description given in section 4. Another good reference, when applicable, is NAVSHIPS 91828, Handbook of Test Methods and Practices. Troubles may vary in nature. Incorrect control settings for a given test may produce apparent troubles. Also, malfunctions in a particular stage may stem from troubles which are actually in the low voltage supply, since this supply acts as a source of power for all stages.

5-2. TEST EQUIPMENT AND SPECIAL TOOLS.

The only special equipment required for troubleshooting and adjustment is an extension cable for the vertical plug-in. The cable may be fabricated as illustrated in figure 5-1. A small screwdriver (0.1 in. wide blade) is required for EF BAL and DC BAL adjustments. Test equipment equivalent to that listed may also be used.

TABLE 5-1. OSCILLOSCOPE AN/USM-117, REQUIRED TEST EQUIPMENT

ITEM	FUNCTION	DESCRIPTION	TYPE NUMBER
1	Measurement of off ground voltages without shock hazard	20,000 ohms/V Multimeter	AN/PSM-4C
2	Measurement of voltage and resistance	Vacuum Tube Voltmeter	AN/USM-116*
3	Signal Source	Time Mark Generator	Tektronix type 180A
4	Signal Source	Sine Wave Generator	TS-382A/U
5	Signal Source	Square Wave Generator	Hewlett Packard model 211A
6	Calibrating Source	Precision Calibrator	Hewlett Packard model 738AR

TABLE 5-1. OSCILLOSCOPE AN/USM-117, REQUIRED TEST EQUIPMENT (Continued)

ITEM	FUNCTION	DESCRIPTION	TYPE NUMBER
7	Measurement of Waveforms	Oscilloscope	AN/USM-105A with MX-2930/ USM-105 Plug-in
8	Measurement of Transistors	Transistor Test Set	TS-1100

*Resistance readings in the voltage-resistance charts were taken with the Hewlett-Packed model 410B vtvm rather than the AN/USM-116. Since the ohmmeter circuit source voltage is different in these instruments, variations in resistance readings should be expected.

5-3. OVERALL TROUBLESHOOTING.

a. PRELIMINARY CHECK. — When no specific cause of trouble is apparent, a good preliminary check is to make a visual inspection of all areas of the instrument for broken or loose wires, broken switch wafers or loose switch mountings, loose control mountings, blown fuses, pointer knobs turned beyond marked positions, and charred wires or components. To make a safe and more careful inspection, remove the power cord from the instrument. After making a check for physical damage, verify all control functions by performing the tests described in paragraphs 3-3 and 3-4. Also make a preliminary amplitude check (using the internal calibrator) and sweep time check. Sweep time may be checked with a fair degree of accuracy by measuring the period of the calibrator waveform which is equal to one millisecond. Preliminary checks should be followed by the troubleshooting procedures outlined in the following paragraphs.

CONNECTOR (AMPHENOL 26-190-16)
NO.16 AG BUSS COVERED WITH TUBING (16 WIRES)
NOTE: EACH WIRE IS SOLDERED BETWEEN ALIKE NUMBERED PINS ON THE CONNECTORS
CONNECTOR (AMPHENOL 26-159-16)
THREADED SPACER 5 5/8" LG. X 3/8 DIA.
SCREW (4 PLACES)

Figure 5-1. Extension Cable for Vertical Plug-in MX-2996/USM-117

b. CONTROL SETTINGS. — Initial control settings of front panel controls are listed in table 5-2. These settings will change, as testing progresses, in accordance with information given in table 5-3 for system troubleshooting.

TABLE 5-2. OSCILLOSCOPE AN/USM-117, PRELIMINARY CONTROL SETTINGS

CONTROL	SETTING
POWER switch	ON
SCALE control	Best display
INTENSITY control	Normal
FOCUS control	Best display
ASTIG control	Best display
POSITION (vert.) control	Trace centered
POSITION (horiz) control	Trace centered
VOLTS/DIV switch	0.1
VARIABLE control	CAL (full cw)
INPUT SELECTOR switch	INPUT A - AC
TRIGGER SLOPE switch	+INT
CONTROL	SETTING
HORIZ MODE switch	SWEEP
HORIZ GAIN control	Full cw

TABLE 5-2. OSCILLOSCOPE AN/USM-117. PRELIMINARY CONTROL SETTINGS (Continued)

CONTROL	SETTING
TIME/DIV switch	0.1 MILLISEC
VARIABLE control	CAL (full cw)
STABILITY control	PRESET
LEVEL control	CENTERED
CALIBRATOR switch	OFF

c. SYSTEM TROUBLESHOOTING CHART. — The over-all troubleshooting chart, table 5-3, indicates the steps to follow after the physical check is completed. This chart gives a cause-and-effect procedure aimed at localizing the trouble in one functional section. Oscilloscope AN/USM-117 is divided into eight functional sections: low voltage power supply, high voltage power supply, vertical plug-in preamplifier, vertical post amplifier, horizontal amplifier, sweep trigger, sweep generator, and calibrator. The NEXT STEP column of table 5-3 refers to one of eight functional section troubleshooting charts. The eight functional section charts include more detailed procedures to isolate the particular part at fault.

Test points are included in the tables and on the schematic diagram to facilitate rapid identification of circuits and functions. These test points are consistent throughout and have the following significance:

Indicates a major test point, used to identify points for checking over-all functions.

Indicates secondary test points, for isolating faults within a unit or sub-assembly.

Indicates minor test points, used to locate test points within a specific circuit.

TABLE 5-3. OSCILLOSCOPE AN/USM-117, SYSTEM TROUBLESHOOTING CHART

STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	Set POWER switch S202 to ON.	Red indicator lamp lights.	If lamp fails to light, turn POWER switch OFF and check power cord, fuses, and POWER switch with power cord unplugged.
2	With HORIZ MODE switch S401 set to X1, rotate horizontal POSITION control R421.	Spot deflects on horizontal axis.	If no spot appears, check low voltage power supply and then high voltage power supply. Also check leads to all deflection plates. If no deflection occurs, check horizontal amplifier.
3	Rotate vertical POSITION control R838.	Spot deflects on vertical axis.	If no deflection occurs, check vertical amplifier.
4	Set HORIZ MODE switch S401 to SWEEP. Advance STABILITY control to FREE RUN.	Trace seen on crt.	If spot rather than trace appears, check sweep generator.

TABLE 5-3. OSCILLOSCOPE AN/USM-117, SYSTEM TROUBLESHOOTING CHART (Continued)

STEP	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5	Reset STABILITY control R725 to PRESET. Set TRIGGER SLOPE switch S501 to +INT. Connect short BNC cable from CALIBRATOR OUTPUT to INPUT A. Adjust LEVEL control R505.	Stable calibrator waveform seen on crt.	If a stable waveform does not appear, check internal trigger amplifier and sweep trigger section. If no waveform appears, check calibrator.

5-4. FUNCTIONAL SECTION TROUBLESHOOTING.

Once the trouble producing section (or sections) of the instrument has been determined, further tests related to that section should be performed to isolate the defective component or transistor. Tests should be conducted in the sequence listed. Remove the cabinet from the instrument and proceed with the appropriate test. Refer to figure 5-2 for location of printed circuit boards and subassemblies.

WARNING

The high crt voltages found in this instrument may be dangerous. The high voltage section contains high voltage points above 2000-volts. One side of R310 located on low voltage supply printed circuit board Z201 is close to 300-volts. When the equipment is in operation, keep your free hand away from the metal frame and any external grounds.

Figure 5-2. Oscilloscope AN/USM-117, Location of Printed Circuit Bords and Subassemblies

a. PRELIMINARY CHECK. -- Further examinations similar to those described in paragraph 5-3a, but in the trouble section rather than overall equipment may prove highly rewarding. Typical tests are listed below:

(1) Inspect for: poor solder joints at terminal points; breaks or cracks in the printed wiring or the printed circuit board itself.

(2) Check for: charred or darkened resistors; dark areas on printed circuit board indicating voltage breakdown.

(3) Inspect for corroded or loose ground lugs and switch terminals.

(4) If crt trace "breaks up", check for corona on high voltage printed circuit board Z301 (remove shield cover) and in the encased high voltage oscillator, located in front of low-voltage transformer T201, just below the crt shield. Subdued lighting or the absence of ambient lighting may aid in the detection of corona.

(5) Particular attention should be given to fuses. If a break in the element occurs below the metal end caps, it may not be detectable to the eye. A continuity check should be made.

b. SCHEMATIC DIAGRAM AND VOLTAGE-RESISTANCE CHART MEASUREMENTS.

(1) All voltage and resistance measurements should be taken with the vtvm, except for transformer and other off ground measurements which require the use of a multimeter to avoid shock hazard. All measurements are made with respect to chassis ground.

(2) When making voltage-resistance chart measurements, use the RX100 range of the vtvm. All measurements are made with the common lead grounded.

(3) For principle control settings and applied signal, refer to applicable schematic diagram given in figures 5-12 through 5-21 and to the applicable voltage-resistance chart given in tables 5-13 through 5-20.

(4) Resistance readings in the voltage-resistance charts were taken with the Hewlett-Packard model 410B vtvm rather than the AN/USM-116. Since the ohmmeter circuit source voltage is different in these instruments, variations in resistance readings should be expected.

c. BASIC TESTS. - Several indicative tests may be performed on transistors suspected of being faulty by using the in-circuit transistor test set listed in table 5-1. Checking transistors which have been removed from the circuit with the multimeter (ohmmeter circuit) is an alternate check. However, it must first be determined if the internal battery of the ohmmeter may be of a high enough voltage to damage the transistor. If in doubt, use the vtvm. Check emitter to collector junctions (most popular cause of trouble) by shorting the base lead to the emitter and connect vtvm common lead and probe in such a manner to back-bias the junction. Back-bias condition may be established as follows: for PNP type transistors connect negative lead to emitter; for NPN type transistors connect negative lead to collector. Check ohmmeter voltage source to determine if black or red test lead is negative polarity. The forward to reverse resistance ratios vary depending upon the type of transistor, particular junction measured and ohmmeter range used; a value of 100 to 1 is about average.

Faulty rectifiers may be identified as follows: open rectifiers produce low output supply voltage with a significant increase in ripple amplitude; shorted units usually cause a power line fuse (F101 and/or F102) to blow. A shorted rectifier pair is a normal case. If this occurs, replace all four rectifiers in that particular bridge circuit, since the other two rectifiers will have, no doubt, been weakened. No replacement should be made until the source of trouble has been found. Rectifiers may also be checked by disconnecting one lead and making a

forward and reverse resistance test. These rectifiers are characterized by extremely high forward to reverse resistance ratios. Zener diodes may also be checked using an ohmmeter. The ohmmeter test current should be low enough to prevent zener action.

d. LOW VOLTAGE POWER SUPPLY.

(1) GENERAL. — Table 5-4 outlines the various tests which should be conducted to isolate a defective component or transistor in the low voltage power supply. The most practical method for checking transistors is an in-circuit voltage comparison test. That is, comparing the actual element voltage of the transistor to those listed on the circuit diagrams. Depending upon the type of transistor used, typical emitter to collector voltages may range from 5.0 volts to 15 volts. The difference voltage between base and emitter is normally a few tenths of a volt. If the transistor is shorted, the emitter voltage nearly equals the collector voltage. If the transistor is open, no current flows through the collector load resistor to produce a voltage drop, so the collector voltage equals the collector supply voltage. Allow about 20 percent variation between actual measurements and the readings indicated on the circuit diagram, figure 5-12, or voltage resistance chart, table 5-13, as the case may be. When replacing power transistors, be sure they are fitted with mica washers coated with silicon grease.

(2) CONTROL SETTINGS. — Set POWER switch S202 to ON. Other controls have no effect on voltage measurements. When making waveform observations, turn the STABILITY control to TRIGGER to inactivate the sweep. This will prevent spurious signals from being superimposed on the ripple waveforms.

NOTE

All measurements referred to on the following charts are made with respect to ground, unless otherwise stated. Line voltage input should be adjusted to 115 volts ac.

TABLE 5-4. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
		+20 VOLT SUPPLY		
1	(A1) Figure 5-3	Measure voltage at junction of CR216 and CR218.	Voltage equal to approximately -16V.	If incorrect, check rectifiers CR215 through CR218, C214, and transformer T201 (terms. 7 and 8).
2	(5) Figure 5-3	Measure voltage at PJ203.	Voltage equal to +20V.	If supply output is high, check Q207 for short. If indication is normal, proceed to step 3.
3	(5) Figure 5-3	Connect test prod of oscilloscope to PJ203.	Waveshape shown in schematic figure 5-12. Ripple equal to 5 mv peak-to-peak.	If ripple is high, substitute Q207, C216, and C215. If ripple is still high (or normal), proceed to step 4.
4	(A2) Figure 5-3	Measure voltage at junction of CR220 and R228.	Voltage equal to approximately +14.5V.	If incorrect, check CR220, R228, and Q209.

TABLE 5-4. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE POWER SUPPLY, FINCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5	(A3) Figure 5-3	Measure voltage at junction of CR219 and R226.	Voltage equal to 11.5V.	If incorrect, check CR219, R226, and Q208.
6		Disconnect + end of C215 and C216 from circuit and measure across each using ohmmeter.	More than 20 megohms with red (+) lead of ohmmeter connected to + lead of capacitor.	If leakage is indicated, replace faulty capacitor. If indication is normal but ripple level is high, capacitor may be open. Substitute new capacitor. If trouble persists, make general voltage test as indicated in step 7.
7		Measure all voltages at elements of Q210, Q209, Q208, and Q207.	Refer to schematic, figure 5-12.	

TABLE 5-4. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
8	(4) Figure 5-3	Measure voltage at junction of CR221 and R235. Disconnect meter and connect test prod of oscilloscope to same point.	Voltage equal to +5V; ripple equal to 3 mv (internal calibrator turned on).	If incorrect, check value of R235. Change CR221.
		-15 VOLT SUPPLY		
9	(A4) Figure 5-3	Measure voltage at junction of C207 and R212.	Voltage equal to approximately -33V.	If incorrect, check rectifiers CR208 through CR211, C205, C206, C207, transformer T201 (terms. 5 and 6).
10	(2) Figure 5-3	Measure voltage at PJ202.	Voltage equal to -15V.	If supply output is high, check Q204 for short. If supply output is low, check C209 for leakage or short. If indications are normal, proceed to step 11.

TABLE 5-4. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
11	(2) Figure 5-3	Connect test prod of oscilloscope to PJ202.	Waveshape shown in schematic, figure 5-12. Ripple equal to 5 mv peak-to-peak.	If ripple is high substitute Q204 and Q208. If ripple is still high (or normal), proceed to step 12.
12	(A_5) Figure 5-3	Measure voltage at junction of CR212 and emitter of Q205.	Voltage equal to -5.2V.	If incorrect, check CR212 and Q205. Also check C208 as indicated in step 6. If indication is normal but ripple is high, capacitor may be open. Substitute new capacitor. If trouble persists, make general voltage test as indicated in step 13.
13		Measure all voltages at elements of Q205 and Q204.	Refer to schematic in figure 5-12.	

TABLE 5-4. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
14	(3) Figure 5-3	Measure voltage at junction of CR213 and R220. Disconnect meter and connect test prod of oscilloscope to same point.	Voltage equal to -5V; ripple equal to 3 mv (internal calibrator turned on).	If incorrect, check value of R220. Change CR213.
	-55 VOLT SUPPLY			
15	(A_6) Figure 5-3	Measure voltage at junction of C201 and R201.	Voltage equal to approximately -73V.	If incorrect, check rectifiers CR201 through CR204, C201, and transformer T201 (terms. 3 and 4).
16	(1) Figure 5-3	Measure voltage at PJ201.	Voltage equal to -55V.	If supply output is high, check Q201 for short. If indication is normal, proceed to step 17.
17	(1) Figure 5-3	Connect test prod of oscilloscope to PJ201.	Waveshape shown in schematic, figure 5-12. Ripple equal to 100 mv peak-to-peak.	If ripple is high, substitute Q201. If ripple is still high (or normal), proceed to step 18.

TABLE 5-4. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
18	(A7) Figure 5-3	Measure voltage at junction of CR205 and R203.	Voltage equal to 29.5V.	If incorrect, check R203 and CR205. Also check C202 as indicated in step 6. If indication is normal but ripple is high, capacitor may be open. Substitute new capacitor. If trouble persists, make general voltage test as indicated in step 19.
19		Measure all voltages at elements of Q201 and Q203.	Refer to schematic in figure 5-12.	

e. HIGH VOLTAGE POWER SUPPLY.

(1) GENERAL. — The procedure outlined in table 5-5 will aid in detecting defective components of the high voltage power supply. Other troubles, less typical by nature, may be traced with power removed from the instrument, using resistance checks. Refer to the voltage-resistance chart, table 5-14, and schematic diagram, figure 5-13.

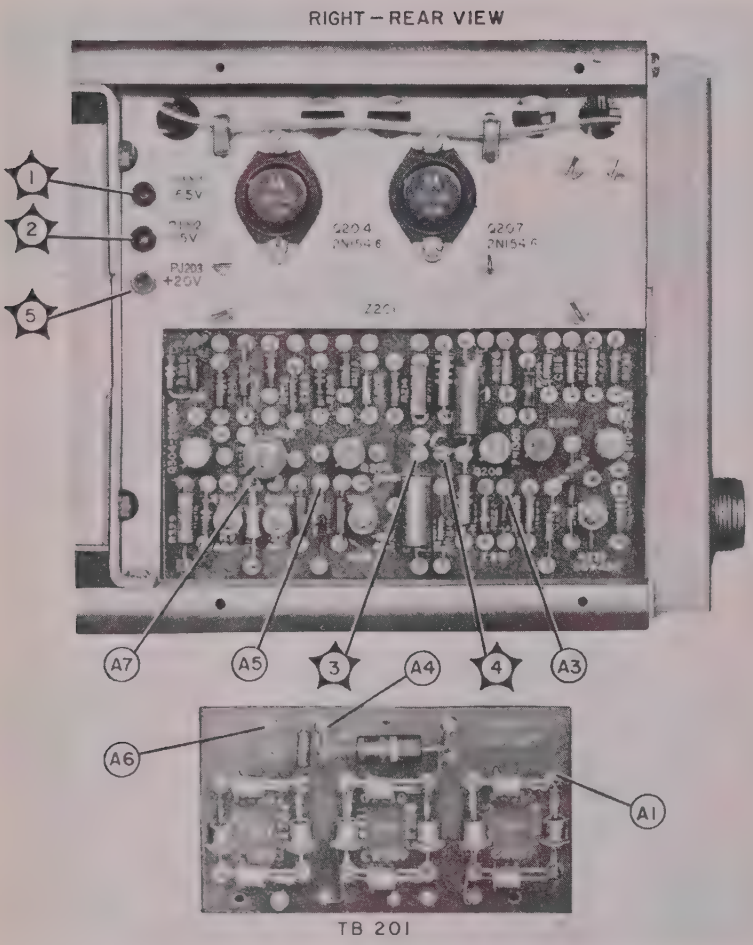


Figure 5-3. Oscilloscope AN/USM-117, Location of Low Voltage Power Supply Test Points

WARNING

When checking voltages related to the high voltage section of the equipment exercise utmost caution, particularly when measuring the cathode and post-accelerating anode voltages of the crt.

(2) CONTROL SETTINGS. -- Like the low voltage power supply, front panel control settings have little effect on the measurements taken. In order to duplicate the direct current readings listed for the unblanking amplifier section, controls should be set as indicated on the schematic, figure 5-13.

NOTE

Before conducting tests outlined in table 5-5, make sure all regulated low voltage points along with the minus 38-volts unregulated source measure their specified value.

TABLE 5-5. OSCILLOSCOPE AN/USM-117, HIGH VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	⑥ Figure 5-4	Measure voltage at PJ301.	Voltage equal to -580V.	If voltage measures more negative, check CR304 and C312 for short or high leakage. If voltage measures less negative, CR304 may be open. Substitute CR304 and C312.

TABLE 5-5. OSCILLOSCOPE AN/USM-117, HIGH VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1 (cont)				If voltage is still incorrect, proceed to step 2; if correct, proceed to step 3.
2	B_3 Figure 5-5	Measure voltage at junction of C308 and CR304 (marked terminal base of HV can).	Voltage equal to approximately -780V.	If incorrect, check CR303, C304, C306, C307, C308, and L301.
3	B_1 Figure 5-5	Measure voltage at junction of CR302 and C303 (marked terminal base of HV can).	Voltage equal to approximately +2400V.	If incorrect, check R303, C302, C303, CR301, and CR302.
4	B_2 Figure 5-5	Measure voltage at junction of C301 and emitter of Q301 (marked terminal base of HV can).	Voltage equal to approximately -23V.	If voltage is low (less than -10V), check Q301 and Q303 for emitter to collector short.
5	B_4	Connect test prod of oscilloscope to junction of term. 1 on T301.	Waveshape shown in schematic, figure 5-13.	If waveshape is nonexistent, check C301 and R301.

TABLE 5-5. OSCILLOSCOPE AN/USM-117, HIGH VOLTAGE POWER SUPPLY, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
	Figure 5-5		Amplitude is approximately 45V peak-to-peak.	
6		Note crt trace pattern in mid sweep ranges (1 MILLISEC to 0.1 MILLISEC).	Uniform intensification of trace.	If trace is bright on one side and dim or dark on the other, check zener diodes CR308 to CR311.

f. VERTICAL PLUG-IN MX-2996/USM-117.

(1) General. — Table 5-6 describes checks to be made if Vertical Plug-in MX-2996/USM-117 becomes inoperative or fails to function properly. Refer to the voltage-resistance chart, table 5-15, and schematic diagrams, figures 5-14 and 5-15.

NOTE

Before conducting tests outlined in table 5-6, make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. — First, set balancing adjustments of the MX-2996/USM-117 plug-in as described in paragraph 3-3b. Voltage readings given in table 5-6 are obtained with the vertical POSITION control set to center the trace, as noted in table 5-2. Note that the readings listed on the schematic, figure 5-14, are obtained with the vertical POSITION control set to its counter-clockwise and clockwise positions respectively.

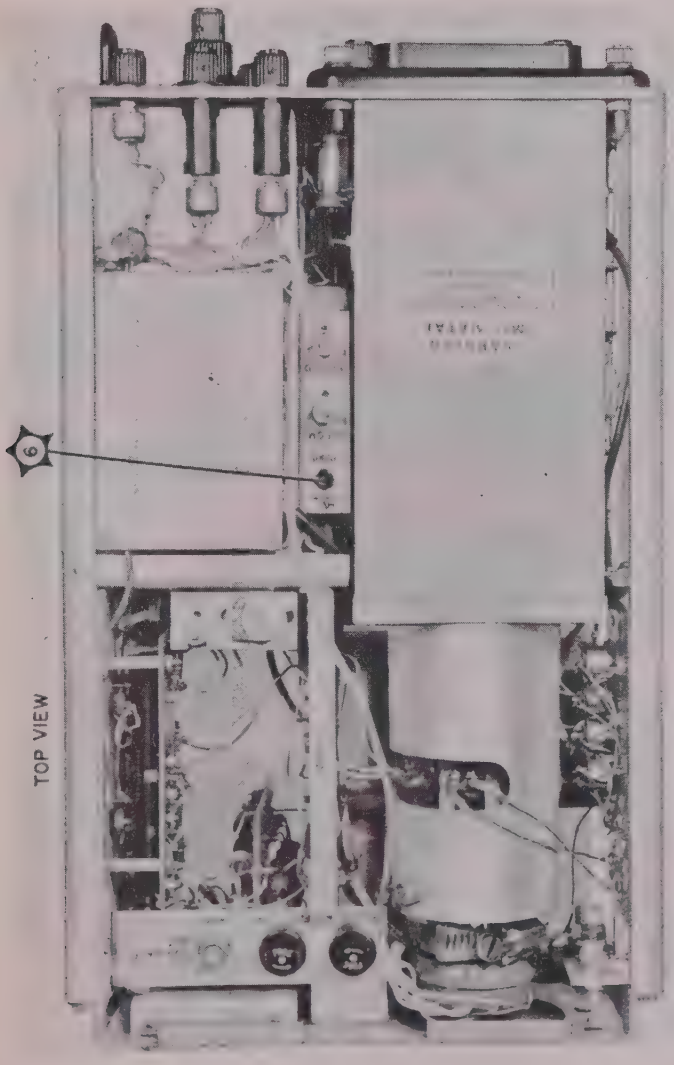


Figure 5-4. Oscilloscope AN/USM-117, Location of High Voltage Power Supply Test Points

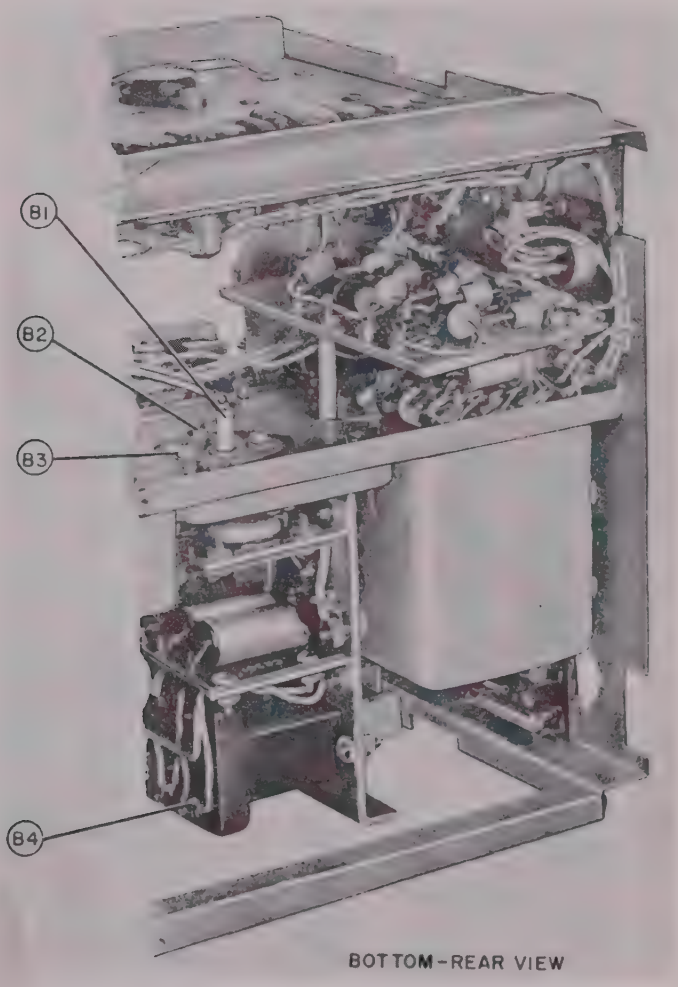


Figure 5-5. Oscilloscope AN/USM-117, Location of High Voltage Power Supply Test Points

TABLE 5-6. OSCILLOSCOPE AN/USM-117, VERTICAL PLUG-IN MX-2996/USM-117, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	(C1) Figure 5-6	Measure voltage at junction of CR801 and CR802.	Voltage equal to zero volts.	If incorrect, check CR801, CR802, and Q801.
2	(C2) Figure 5-6	Measure voltage at junction of emitter of Q803 and base of Q804.	Voltage equal to approximately -0.8V.	If incorrect, check Q801, Q802, and Q803.
3	(C3) Figure 5-6	Measure voltage at junction of R823 and R827.	Voltage equal to approximately -0.8V.	If reading equals zero volts, check C823 for short.
4	(C4) (C5) Figure 5-6	Measure voltage at junction of R832 and R837; then at junction of R834 and R839.	Voltage equal to approximately -1.8V at both points.	If incorrect, check Q804 and Q806.
5	(C6) (C7) Figure 5-7	Measure voltage at pin 1 of J803; then at pin 9 of J803.	Voltage equal to approximately -1.5V at both points.	If incorrect, check Q805 and Q807.
6	(C6) (C7) Figure 5-7	Rotate vertical POSITION control CCW then CW.	Voltage swing equal to approximately 0.7V each side of 1.5V reading.	If incorrect, check R838, R837, R839, Q805, and Q807.

TABLE 5-6. OSCILLOSCOPE AN/USM-117, VERTICAL PLUG-IN MX-2996/USM-117, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
7	(C1) through (C7) Figures 5-6, 5-7	Connect short BNC cable between CALIBRATOR OUTPUT and INPUT A-AC. Set CALIBRATOR switch to 0.4 VOLTS. Set VOLTS/DIV switch to 0.05. Connect test prod of oscilloscope to test points (C1) to (C7) in succession.	Voltage gain of signal between (C1) and (C2) is approximately X1. Voltage gain from (C2) to (C4) is approximately X5; signal at (C5) is equal in amplitude to signal at (C4) Gain from (C4) to (C6) and (C5) to (C7) is X1.	After localizing trouble by signal tracing method, check individual components in the defective stage.

g. VERTICAL POST AMPLIFIER.

Since the vertical post amplifier and Vertical Plug-in MX-2996/USM-117 function together to amplify the applied vertical signal, the troubleshooting procedure for the vertical post amplifier is simply an extension of that listed in table 5-6. Test conditions are unchanged. Refer to the voltage-resistance chart, table 5-16, and schematic diagram, figure 5-16.

NOTE

Before conducting tests outlined in table 5-7 make sure all regulated low voltage points measure their specified value.

Figure 5-6. Oscilloscope AN/USM-117, Location of MX-2996/USM-117 Plug-in Test Points

TABLE 5-7. OSCILLOSCOPE AN/USM-117, VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	(D2) (D3) Figure 5-7	Measure voltage at collector of Q605, then at collector of Q607.	Voltage equal to approximately -2.8V at both points.	If reading is high, in the order of -3.5V, at the collector of Q605, check DL601 for open circuit. If high reading is obtained at collector of Q607 check DL602 for open circuit. If reading is low, near zero volts at collector of Q605, check Q605 for collector to emitter short. If reading is low at collector of Q607, check Q607 for collector to emitter short.
2	(D4) (D5) Figure 5-7	Measure voltage at emitter of Q608, then at emitter of Q609.	Voltage equal to approximately -2.5V at both points.	If incorrect, check respective transistor (Q608 or Q609) for emitter to collector short.

TABLE 5-7. OSCILLOSCOPE AN/USM-117, VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
3	(D6) (D7) Figure 5-7	Measure voltage at collector of Q604, then at collector of Q603.	Voltage equal to approximately -29V at both points.	If incorrect at collector of Q604, check Q604 and Q602. If incorrect at collector of Q603, check Q603 and Q601.
4	(C6) (D1) Figure 5-7	Connect short BNC cable between CALIBRATOR OUTPUT and INPUT A-AC. Set CALIBRATOR switch to 0.4V. Set VOLTS/DIV switch to 0.05. Connect test prod of oscilloscope to test points (C6) and (D1) in succession.	Voltage gain of signal between (C6) and (D1) is approximately X1.5 or more.	If incorrect, check C602 for short. Check Q606 for collector to emitter short.

TABLE 5-7. OSCILLOSCOPE AN/USM-117, VERTICAL POST AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
5	C_6 through D_7 Figure 5-7	Connect input signal as described in step 4. Connect test prod of oscilloscope to test points C_6 through D_7 in succession.	Voltage gain of signal (measured with respect to ground) between C_6 and D_3 is approximately X2. Same figure applies for gain between C_7 and D_2. Voltage gain between D_2 and D_4 approximately X1. Same figure applies between D_3 and D_5. Voltage gain between D_4 and D_6 is approximately X17. Same figure applies between D_5 and D_7.	After localizing trouble by signal tracing method, check individual components in the defective stage.

h. HORIZONTAL AMPLIFIER.

(1) GENERAL. — Table 5-8 describes checks to be made if the horizontal amplifier becomes inoperative or fails to function properly. Refer to the voltage-resistance chart, table 5-17, and schematic diagram, figure 5-17.

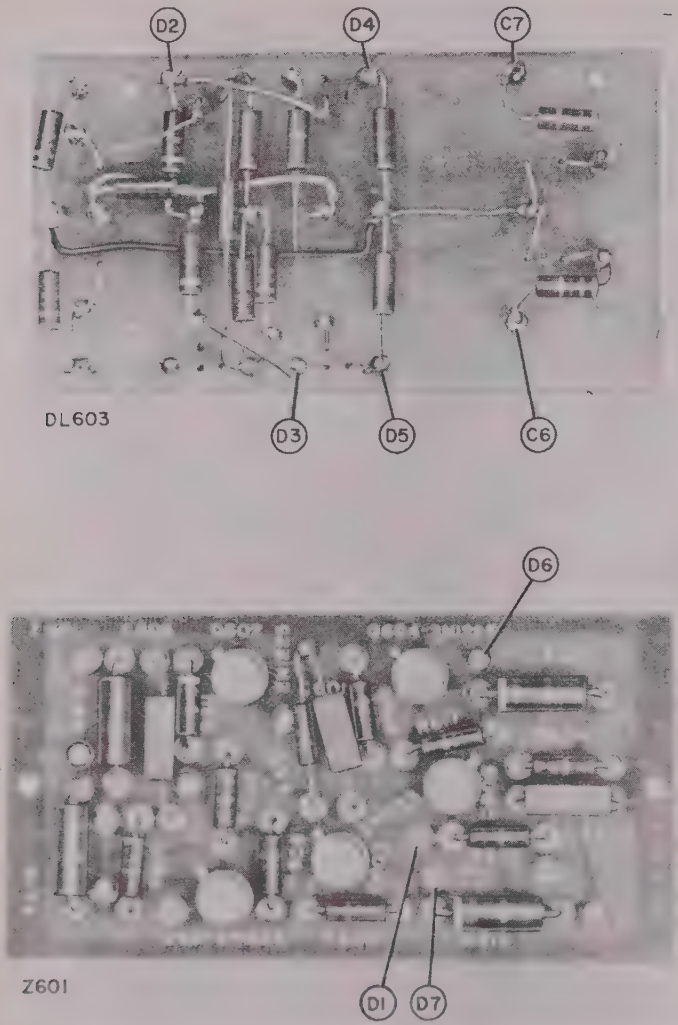


Figure 5-7. Oscilloscope AN/USM-117, Location of Post Amplifier Test Points

NOTE

Before conducting tests outlined in table 5-8, make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. — An internal adjustment, ZERO ADJ R408, should be checked before proceeding with the tests outlined in table 5-8. Refer to paragraph 6-2h (1) for the adjustment procedure. Panel controls are set in accordance with table 5-2, except the STABILITY control which is advanced to the FREE RUN position. Voltage readings given in table 5-8 are obtained with horizontal POSITION control set to center the trace, as noted in table 5-2. Note that the readings listed on the schematic (figure 5-17) are obtained with the horizontal POSITION control set to its counterclockwise and clockwise positions respectively.

NOTE

Since the BIAS ADJ control R430 is set for optimum sweep linearity in individual instruments, the inherent variation in dc levels may be somewhat more than in other circuits. Any radical difference in these levels, however, from those listed, should be considered as an indication of trouble.

TABLE 5-8. OSCILLOSCOPE AN/USM-117, HORIZONTAL AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	(E2) Figure 5-8	Measure voltage at collector Q401.	Voltage equal to approximately -1.0V.	If incorrect, check adjustment of ZERO ADJ control R408. Refer to paragraph 6-2h. (1). If adjustment is correct but voltage at (E5) incorrect, proceed to step 2.

TABLE 5-8. OSCILLOSCOPE AN/USM-117, HORIZONTAL AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
2	(E1) (E2) Figure 5-8	Connect test prod of oscilloscope to base of Q401, then to emitter of Q401.	Negative-going sawtooth waveform of 1.7V peak-to-peak.	If waveform is absent, refer to table 5-10. If waveform is present at (E1) but not at (E2), check Q401 for emitter to collector short.
3	(E3) Figure 5-8	Measure voltage at base of Q404.	Voltage equal to approximately -1.2V.	If incorrect, rotate horizontal POSITION control slightly. If reading is unchanged, manipulate detent of HORIZ MODE switch S401 checking connection continuity.
4	(E4) Figure 5-8	Connect test prod of oscilloscope to base of Q405.	Negative-going sawtooth waveform of 1.7V peak-to-peak.	If waveform is absent check switch S401 as indicated in step 3.
5	(E5) (E6) Figure 5-8	Measure voltage at collector of Q404, then at collector of Q405.	Voltage equal to approximately -23V at (E5) and -38V at (E6)	If incorrect, check Q404 and Q405. Also check continuity from Q402 to Q404 through S401.

TABLE 5-8. OSCILLOSCOPE AN/USM-117, HORIZONTAL AMPLIFIER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
6	E_4 through E_6 Figure 5-8	Connect test prod of oscilloscope to test points E_4 to E_6 in succession.	Voltage gain from E_4 to E_6 is approximately X20; signal at E_6 is equal in amplitude to signal at E_5.	After localizing trouble to either side of balanced output stage, check individual components in that area.

i. SWEEP TRIGGER.

(1) GENERAL. — Any form of instability of the crt presentation, other than actual trace shift, is indicative of trouble in the sweep trigger circuit. If such instability (jitter, random motion, etc.) is observed, follow the troubleshooting procedure given in table 5-9. First, however, check the applied waveform on an oscilloscope known to be in good working order to make sure the trouble does not stem from the applied signal itself. Refer to the voltage-resistance chart, table 5-18, and schematic diagram, figure 5-18.

NOTE

Before conducting tests outlined in table 5-9 make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. — Although controls are set in accordance with table 5-2, the setting of the LEVEL control must be made very precisely for electrical center rather than

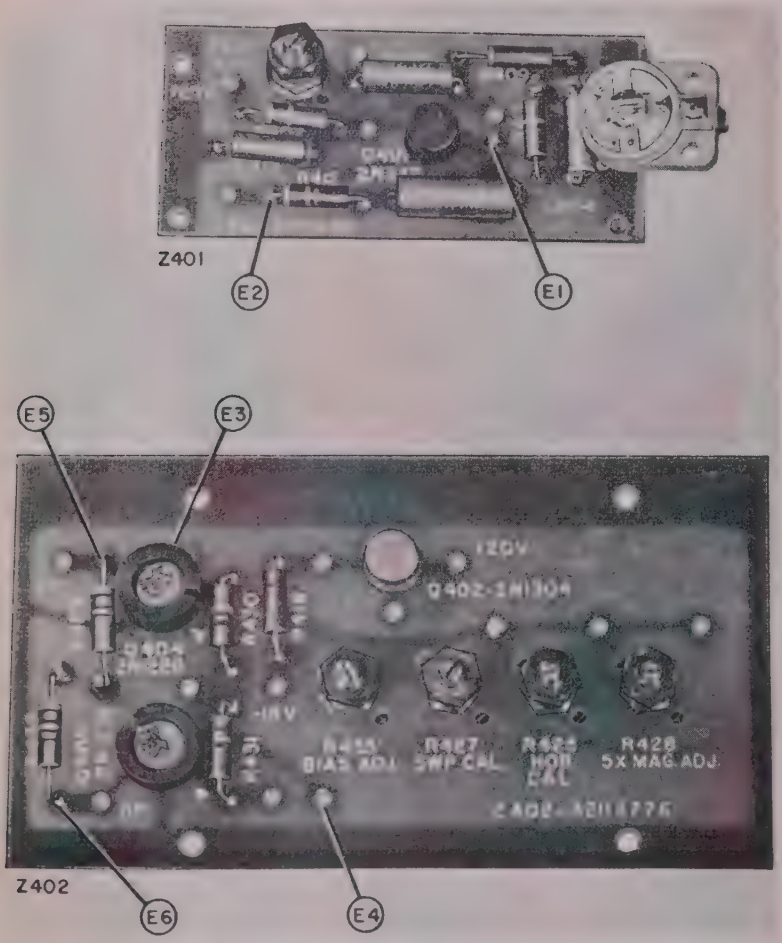


Figure 5-8. Oscilloscope AN/USM-117, Location of Horizontal Amplifier Test Points

physical centering. Otherwise, it would not be possible to duplicate the dc levels listed in table 5-9 or on the schematic, figure 5-18. Apply a 10kc, 0.5-volt peak-to-peak sine wave to INPUT A-AC. Rotate the LEVEL control until the start of the trace is midway between the negative and positive peaks of the displayed waveform.

NOTE

Although meter loading effects may cause the crt display to disappear when testing the Schmitt trigger section of the sweep trigger circuit, the voltage readings themselves are not affected. Advancing the STABILITY control from PRESET to TRIG will restore the display when the meter is connected into the circuit.

TABLE 5-9. OSCILLOSCOPE AN/USM-117, SWEEP TRIGGER. FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	(F1) (F3) Figure 5-9	Measure voltage at base of Q501, then at base of Q502.	Voltage equal to less than 0.1 volt.	If voltage at (F1) is incorrect, check C505 for short or leakage. If voltage at (F3) is incorrect, recheck adjustment procedure stated in last sentence of paragraph 5-4i (2).
2	(F4) Figure 5-9	Measure voltage at collector of Q502.	Voltage equal to approximately -9.3V.	If incorrect, check Q502 for emitter to collector short or open.

TABLE 5-9. OSCILLOSCOPE AN/USM-117, SWEEP TRIGGER, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
		Measure voltage at F_4 while rotating LEVEL control back and forth.	Voltage swings above and below -9.3V.	If no swing is indicated, check C503 for short. Return LEVEL control to proper setting.
3	F_5 Figure 5-9	Measure voltage at collector of Q504.	Voltage equal to approximately -14.2V.	If incorrect, check all voltages at elements of Q503 and Q504 (refer to schematic of figure 5-18) to localize trouble. Perform resistance checks if necessary.
4	F_1 through F_5 Figure 5-9	Connect test prod of oscilloscope to test points F_1 to F_5 in succession.	Voltage gain between F_1 and F_4 is approximately X10. Waveshape at F_5 is about one-quarter of the amplitude at F_4 but has fast rise and fall times.	After localizing trouble by signal tracing method, check individual components in the defective stage.

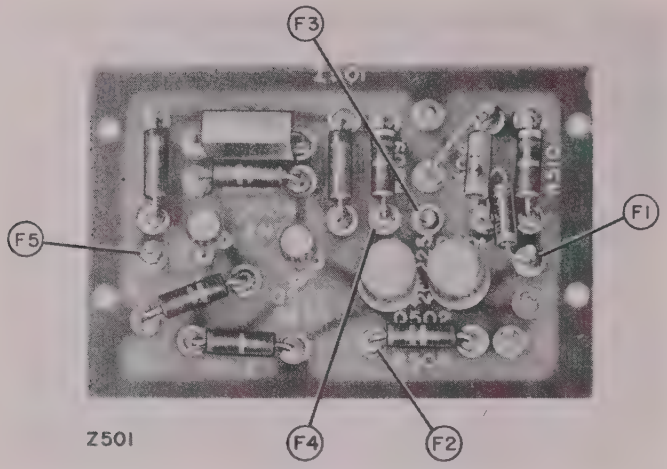


Figure 5-9. Oscilloscope AN/USM-117, Location of Sweep Generator Test Points

j. SWEEP GENERATOR.

(1) GENERAL. — The sweep generator is the most difficult of all circuits to troubleshoot. This is because all stages of the sweep circuit operate within a loop. Any change from a normal voltage level in a given stage causes a corresponding change in all voltage levels throughout the loop. For this reason, voltage values listed on the sweep generator schematic, figure 5-19, are less helpful than in other circuit areas.

Basic troubles in the sweep generator circuit may be considered in two parts: (1) will the beam trace? (2) will the beam retrace? Typical trouble areas related to these effects are noted in table 5-10. Refer to the voltage-resistance chart, table 5-19, and schematic diagrams, figures 5-19 and 5-20.

NOTE

Before conducting tests outlined in table 5-10 make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. — Set controls in accordance with table 5-2. Triggering controls must be adjusted for a stable presentation of the applied 10 kc, 0.5-volt peak-to-peak signal (refer to paragraph 5-4i(2).

TABLE 5-10. OSCILLOSCOPE AN/USM-117, SWEEP GENERATOR, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	(G1) Figure 5-10	Connect test prod of oscilloscope to base of Q701.	Waveform shown in schematic of figure 5-19.	If proper waveform is not present at (G1), check (F5) for triggering waveform. If beam is locked to left hand side of screen, see step 2. If beam is locked to right hand side of screen, see step 3.
2	(G4) Figure 5-10	Measure voltage at emitter of Q705.	Voltage equal to approximately -3.4V. *	If reading is near zero volt, substitute Q701 and Q702.
3		Same test as in step 2.	Voltage equal to approximately -3.4V. *	If reading is above 10 volts, substitute Q710 and Q711.

TABLE 5-10. OSCILLOSCOPE AN/USM-117, SWEEP GENERATOR, FUNCTIONAL TROUBLESHOOTING CHART (Continued)

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
4	(G1) through (G6) Figure 5-10	Connect test prod of oscilloscope, to test points (G1) to (G6) in succession	Waveforms shown in schematic of figure 5-19.	If waveform is present but unlike the one illustrated, check individual components in the related circuit area.

*Note: Refer to note 3 in Voltage-Resistance Chart, table 5-19.

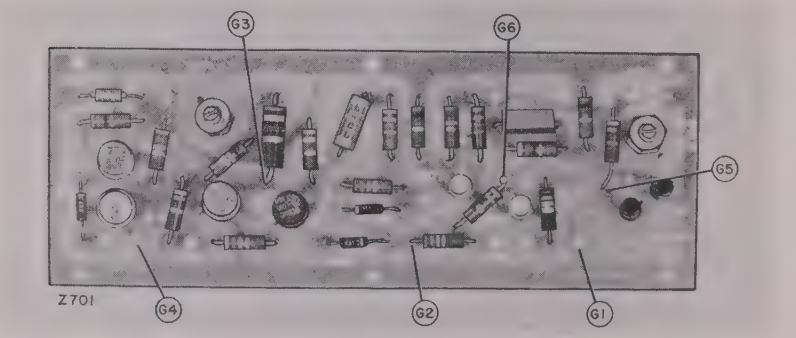


Figure 5-10. Oscilloscope AN/USM-117, Location of Sweep Generator Test Points

k. CALIBRATOR.

(1) GENERAL. — Table 5-11 describes checks to be made if the calibrator becomes inoperative or fails to function properly. Refer to the voltage-resistance chart, table 5-20, and schematic diagram, figure 5-21.

NOTE

Before conducting tests outlined in table 5-11 make sure all regulated low voltage points measure their specified value.

(2) CONTROL SETTINGS. - In these tests the CALIBRATOR is set to the 0.4 position rather than the OFF position, as indicated in table 5-2.

TABLE 5-11. OSCILLOSCOPE AN/USM-117, CALIBRATOR, FUNCTIONAL TROUBLESHOOTING CHART

STEP	TEST POINT	PRELIMINARY ACTION	NORMAL INDICATION	NEXT STEP
1	(H1) Figure 5-11	Connect test prod of oscilloscope to base of Q102.	Sine wave of approximately 1.5V peak-to-peak with slight distortion.	If waveform is not present, replace Q101 or check it for emitter to collector short.
2	(H2) Figure 5-11	Connect test prod of oscilloscope to collector of Q103.	Square wave of approximately 8V peak-to-peak.	If incorrect, check Q102 and Q103.
3	(H3)	Connect test prod of oscilloscope to junction of R113 and R114.	Square wave of 0.4V peak-to-peak.	If waveform is not present, check CR101 for open and CR102 for short; if amplitude is incorrect, reset CAL ADJ control R112.

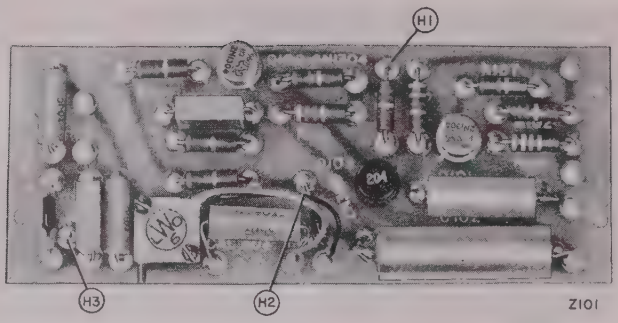


Figure 5-11. Oscilloscope AN/USM-117, Location of Calibrator Test Points

5-5. TYPICAL TROUBLES.

Table 5-12 lists troubles of a general nature which could occur in Oscilloscope AN/USM-117. Tests are conducted with front panel controls set in accordance with table 5-2.

Symptoms, possible causes, and repair steps are given. If a breakdown occurs, the symptoms should be noted, the nature of the trouble determined, and the fault identified.

TABLE 5-12. OSCILLOSCOPE AN/USM-117, TYPICAL TROUBLES

SYMPTOM	POSSIBLE CAUSE	REPAIR
Spot absent on crt.	Defective high or low voltage supplies; defective crt.	Check for open heater in crt; check C301 for open or short; check all HV filter capacitors; check fuses F201 and F202.
Spot absent on crt.	Spot off screen.	Check DC BAL and EF BAL adjustments; dc at vertical input too high; loose deflection plate lead connection on crt.
Ripple on trace.	Defective filter in low voltage supply; noisy input transistor.	Check C210, C219, C201, and C209. Replace Q801.
Loss of calibrated sensitivity (vert.).	Change in high or low voltage; change in plug-in or post amplifier gain.	Check -580V at PJ301; check all low voltage supplies. Check setting of .01V ADJ and GAIN ADJ controls.
Loss of calibrated sensitivity (horiz).	Change in high or low voltage; change in horizontal amplifier gain.	Check -580V at PJ301; check all low voltage supplies. Check setting of HORIZ CAL control.

TABLE 5-12. OSCILLOSCOPE AN/USM-117, TYPICAL TROUBLES (Continued)

SYMPTOM	POSSIBLE CAUSE	REPAIR
No sweep but external horizontal signals offer deflection.	Defective or misadjusted sweep circuit.	Check transistors in sweep circuit. Check setting of SWP LGTH control.
No sweep and external horizontal input inoperative.	Defective horizontal amplifier.	Check transistors in horizontal amplifier.
No LEVEL control action.	No bias swing in trigger amplifier.	Shorted C503.
Poor triggering (internal only).	Defective internal trigger amplifier.	Replace Q606.
Square wave distortion.	Incorrect compensation adjustment.	Check adjustment of all capacitors in input attenuator plus C817, C821, C822, and C605A.

TABLE 5-13. OSCILLOSCOPE AN/USM-117, LOW VOLTAGE POWER SUPPLY, VOLTAGE-RESISTANCE CHART

TSTR NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q201	PNP	-55V	-55V	-73V	1.7K	1.8K	1.7K
Q202	PNP	-29.5V	-29.4V	-55V	5.0K	2.0K	1.8K
Q204	PNP	-15V	-15V	-33V	200	250	180
Q205	PNP	-5.2V	-5.4V	-15V	300K[2]	500	250
Q207	PNP	0V	-0.15V	-16V	0	90	70[3]
Q208	PNP	+11.5V	+11.2V	-0.15V	1.2K	400	90
Q209	PNP	+14.8V	+14.5V	+11.2V	2.0K	700	400
Q210	PNP	+14.8V	+14.5V	0V	2.0K	240	0

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measure on RX10K range (large variation).
3. Measure on RX10 range (large variation).

TABLE 5-14. OSCILLOSCOPE AN/USM-117, HIGH VOLTAGE SUPPLY AND CRT, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q301	PNP	0V	+5.0V	-23V	0	50	25[2]
Q302	PNP	0V	+5.0V	-23V	0	50	25[2]
Q303	PNP	-23.5V	-23.8V	-29V	100[2]	110	70
Q304	PNP	-2.3V	-2.4V	-23.8V	1.0K	400	120
Q305	PNP	-0.52	-0.78	-35V	270	600	2.3K
Q306	PNP	-35V	-35V	-55V	22K[3]	2.3K	1.8K

V301 Crt cathode E = -580V (Test point PJ301, 6)
R = 1.0 MEG (RX10K range)

(CRT) Crt anode E = +2400V (See WARNING paragraph 5-4e.(1)) Use AN/PSM-46, 4KV Range.
R = 500K (RX 10K range; neg. polarity)

Check only crt elements which are listed above.

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measure on RX1 range.
3. Measure on RX1K range.

TABLE 5-15. OSCILLOSCOPE AN/USM-117, VERTICAL PLUG-IN, MX-2996/USM-117, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q801	NPN	-0.54V	0V	+4.8V	5.0K	1.5K	1.0K
Q802	NPN	-1.1V	-0.54V	+4.8V	750	5.0K	1.0K
Q803	PNP	-0.8V	-1.1V	-5.0V	900	750	350
Q804	PNP	-0.48V	-0.8V	-1.8V	3.0K	900	700
Q805	PNP	-1.5V	-1.8V	-8.0V	600	700	450
Q806	PNP	-0.48V	-0.8V	-1.8V	3.0K	220	700
Q807	PNP	-1.5V	-1.8V	-8.0V	600	700	450

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.

TABLE 5-16. OSCILLOSCOPE AN/USM-117, VERTICAL POST AMPLIFIER, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q601	PNP	-2.5V	-3.0V	-13.8V	3.0K	850	NOTE 3
Q602	PNP	-2.5V	-3.0V	-13.8V	3.0K	850	NOTE 3
Q603	PNP	-13.8V	-14V	-28V	NOTE 3	4.5K	5.0K
Q604	PNP	-13.8V	-14V	-28V	NOTE 3	4.5K	5.0K
Q605	PNP	-0.4V	-0.7V	-3.0V	1.3K	300	650
Q606	PNP	-0.1V	-0.3V	-13.5V	100	400	3.0K
Q607	PNP	-0.4V	-0.7V	-3.0V	1.3K	300	650
Q608	PNP	-2.8V	-3.0V	-6.8V	850	650	1.8K
Q609	PNP	-2.8V	-3.0V	-6.8V	850	650	1.8K

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.
2. Measurements taken with trace centered vertically.
3. Large variations between units; average value is 300K.
4. Voltage figures may vary depending on value of R620 and R621.

TABLE 5-17. OSCILLOSCOPE AN/USM-117, HORIZONTAL AMPLIFIER, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q401	NPN	-0.9V	-0.3V	+20V	2.0K	10K	300
Q402	NPN	-1.3V	-1.2V	+20V	240	120	250
Q404	PNP	-1.2V	-1.3V	-23V	4.5K	250	11K
Q405	PNP	-0.85V	-1.0V	-37V	4.5K	2.0K	11K

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b for general notes.

2. Measurements taken with trace centered horizontally.

TABLE 5-18. OSCILLOSCOPE AN/USM-117, SWEEP TRIGGER, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q501	PNP	+0.2V	0 ±1V	-15V	11K	450	220
Q502	PNP	+0.2V	0 ±1V	-9.3V	11K	1.8K	2.0K
Q503	PNP	-10 V	-9.3 V	-13.2V	16K[2]	2.0K	2.8K
Q504	PNP	-10 V	-8.0 V	-14.2V	16K[2]	2.5K	3.0K

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b. for general notes.

2. Set LEVEL control as outlined in paragraph 5-4i(2).

TABLE 5-19. OSCILLOSCOPE AN/USM-117, SWEEP GENERATOR, VOLTAGE-RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q701	PNP	+5.8V	+5.6V	0V	7.5K	1.0K	800
Q702	PNP	+5.8V	+5.7V	+0.1V[2]	7.5K	1.1K	900
Q703	NPN	-0.78V	0V	+20V	600	800	300

TABLE 5-19. OSCILLOSCOPE AN/USM-117, SWEEP GENERATOR, VOLTAGE-RESISTANCE CHART (Continued)

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q705	PNP	-3.0V[3]	-3.2V[3]	-24V	9K	2.8K	3.5K
Q706	NPN	-0.15V	+0.45V	+17.5V	260	60K[4]	4.0K
Q709	PNP	0V	-0.15V	-7.0V[3]	0	280	10K
Q710	PNP	+5.6V	+5.2V	0V	1.0K	1.7K	0
Q711	PNP	+5.2V	+4.8V	0V	1.7K	1.9K	0
Q712	PNP	+10V	+10✓	0V	30K[4]	270	0

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b. for general notes.
2. Variation may exceed 0.1 volts.
3. Value depends upon setting of STABILITY and/or PRESET.
4. Measure on RX1K range.

TABLE 5-20. OSCILLOSCOPE AN/USM-117, CALIBRATOR, VOLTAGE RESISTANCE CHART

TSTR. NO.	TYPE	VOLTAGE (VOLTS) JUNCTION			RESISTANCE (OHMS) JUNCTION		
		E	B	C	E	B	C
Q101	NPN	-4.4V	-5.0V	+5.0V	450	1.5K	450
Q102	NPN	-4.4V	-4.6V	-1.8V	400	700	500
Q103	NPN	-4.4V	-4.5V	-0.15V[2]	400	700	500

MEASUREMENT NOTES:

1. All measurements taken on RX100 range with vtvm. Refer to paragraph 5-4b. for general notes.

2. Variation may exceed 1 volt.

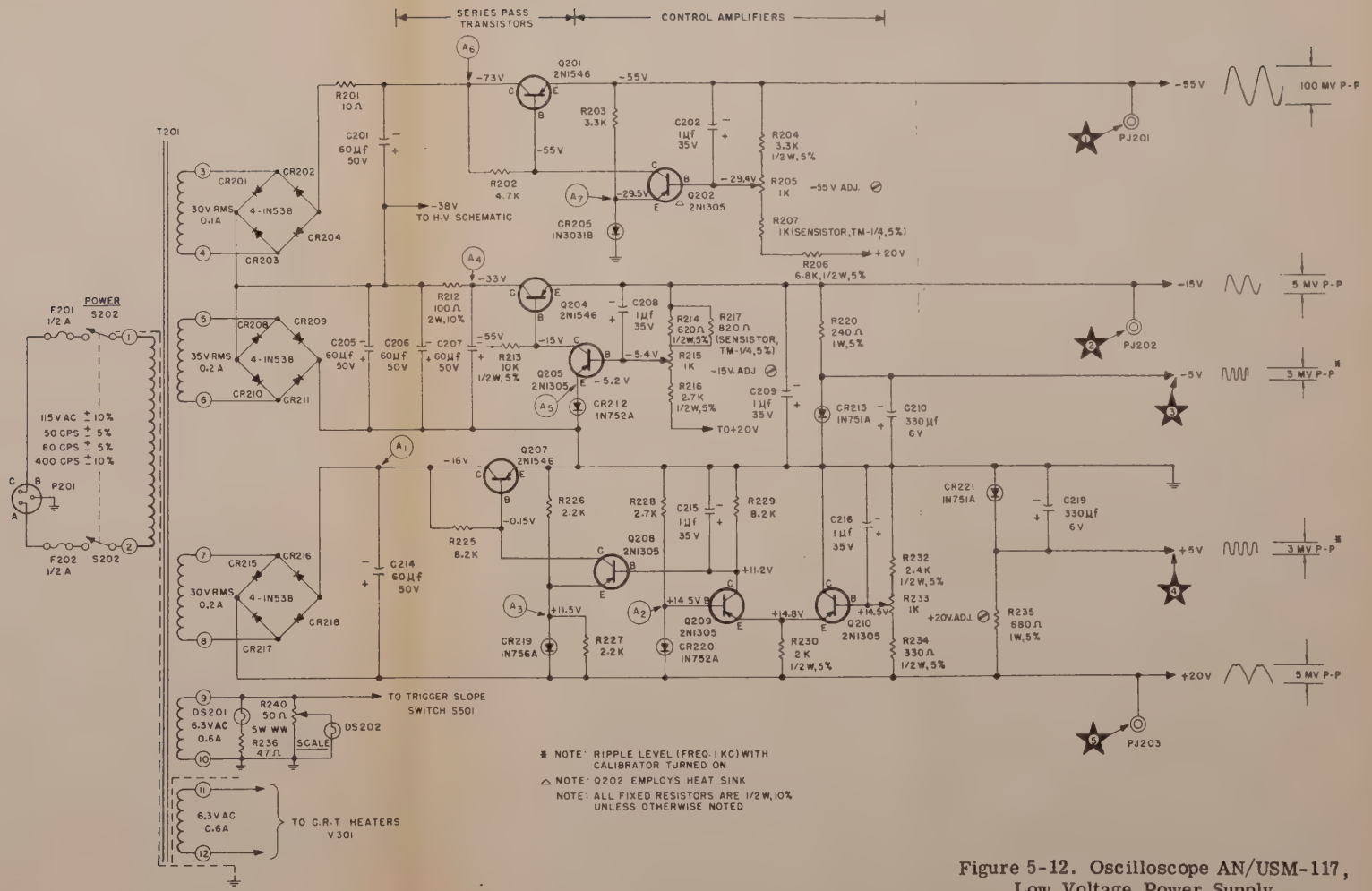
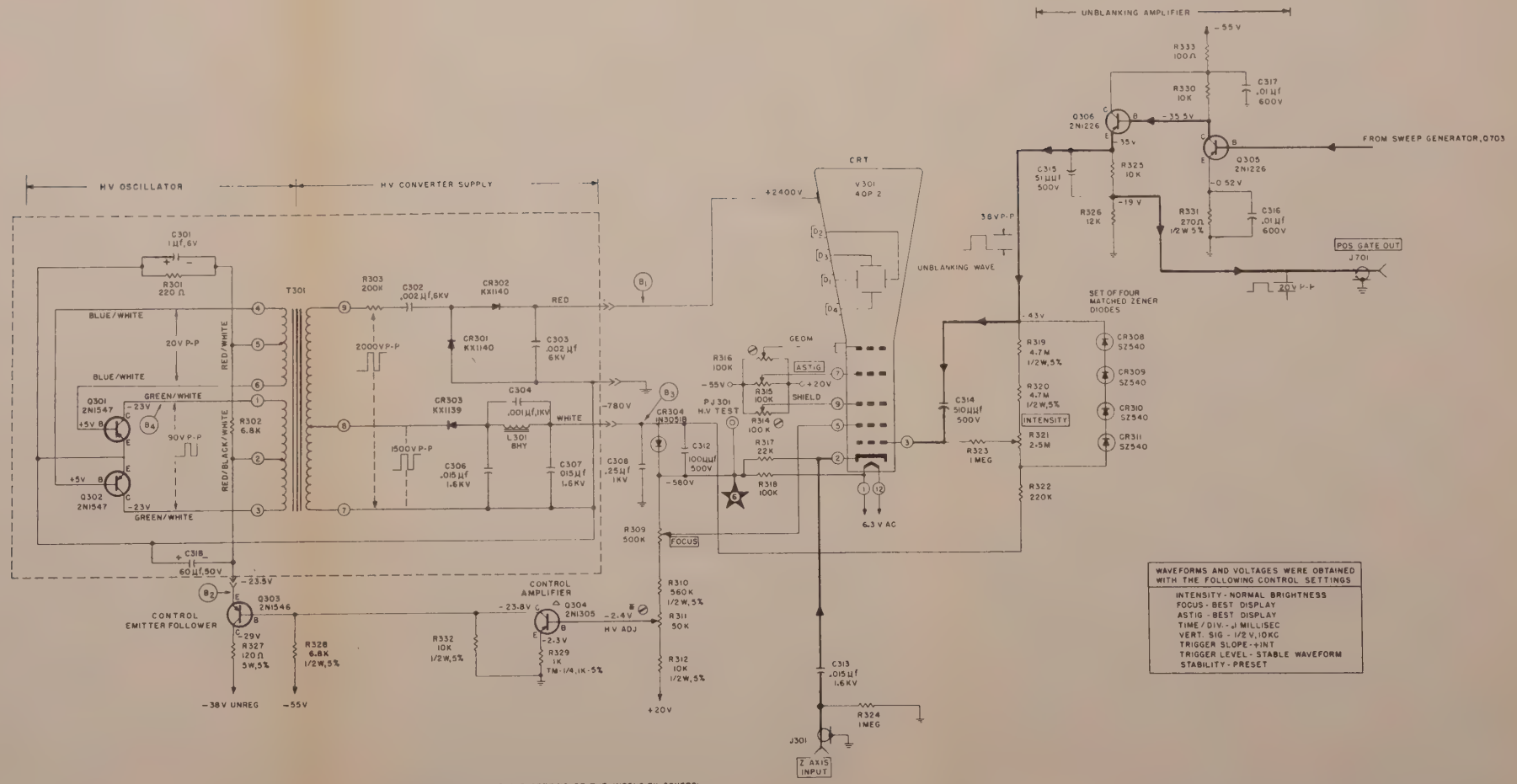


Figure 5-12. Oscilloscope AN/USM-117, Low Voltage Power Supply, Schematic Diagram

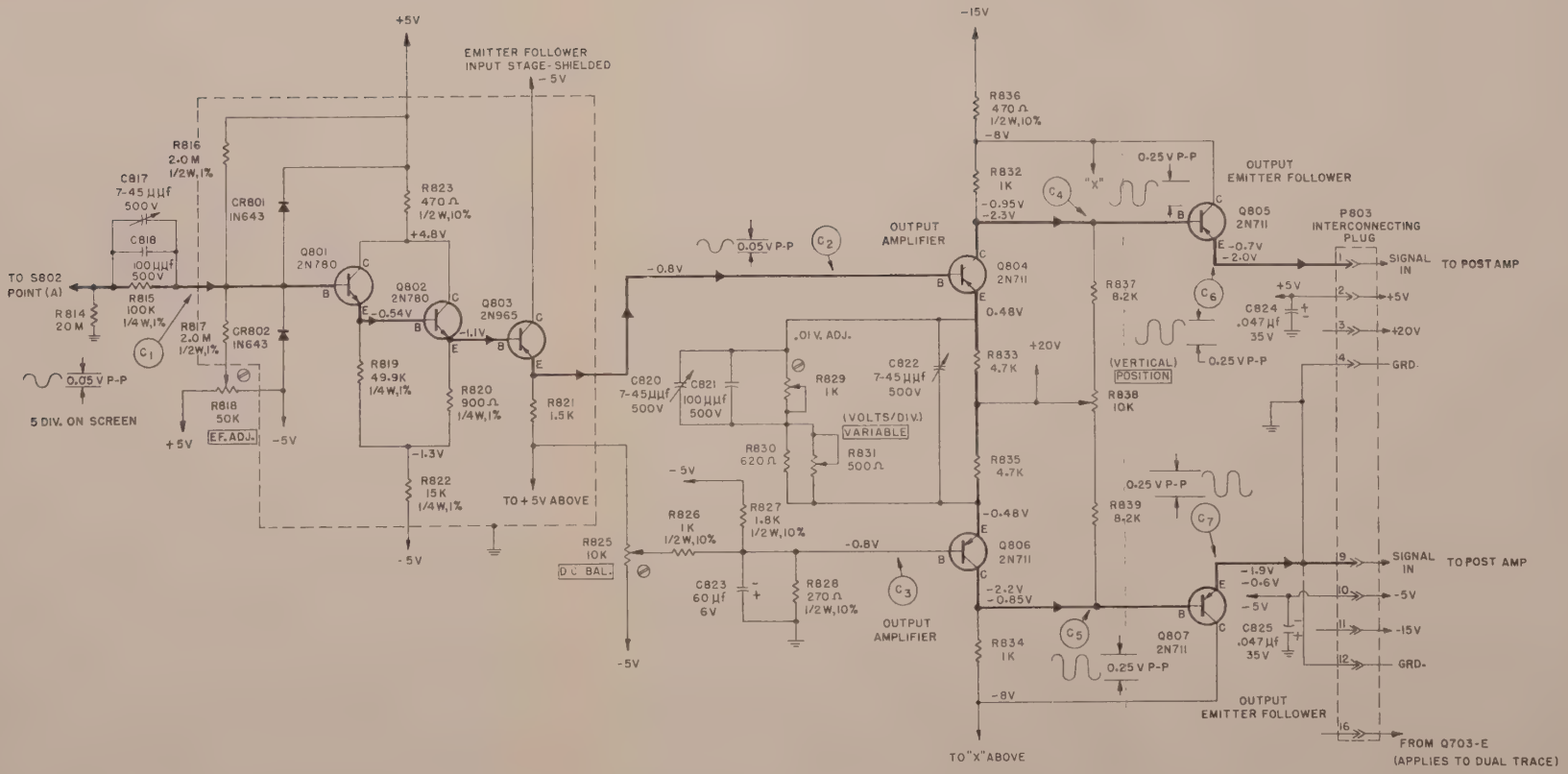


* NOTE: FOR NORMAL OR AVERAGE SETTING OF THE INTENSITY CONTROL; MEASURE WITH VTVM ONLY

△ NOTE: Q304 EMPLOYS HEAT SINK

NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED

Figure 5-13. Oscilloscope AN/USM-117, High Voltage Power Supply and CRT, Schematic Diagram



NOTE: ALL FIXED RESISTORS ARE 1/2W,5% UNLESS OTHERWISE NOTED

WAVEFORMS AND VOLTAGES WERE OBTAINED WITH THE FOLLOWING CONTROL SETTINGS
VOLTS/DIV.–0.1 VERTICAL POSITION–CCW (UPPER READING) CW (LOWER READING) VARIABLE–CAL. POSITION INPUT SELECTOR–DC INPUT A INPUT SIGNAL–10 KC, 0.5 V P-P

Figure 5-14. Oscilloscope AN/USM-117, Vertical Plug-in MX-2996/USM-117, Preamplifier, Schematic Diagram

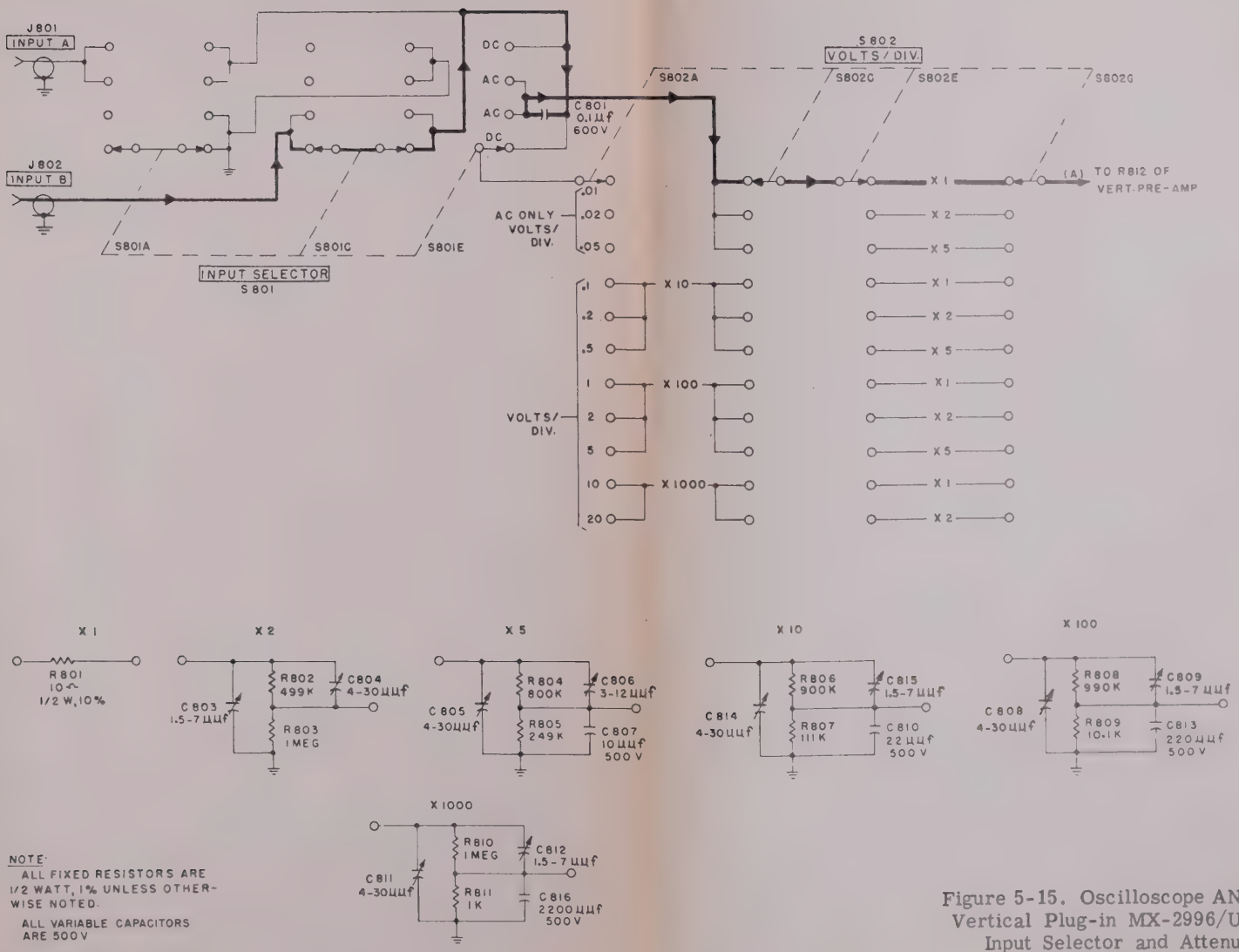


Figure 5-15. Oscilloscope AN/USM-117, Vertical Plug-in MX-2996/USM-117, Input Selector and Attenuator, Schematic Diagram

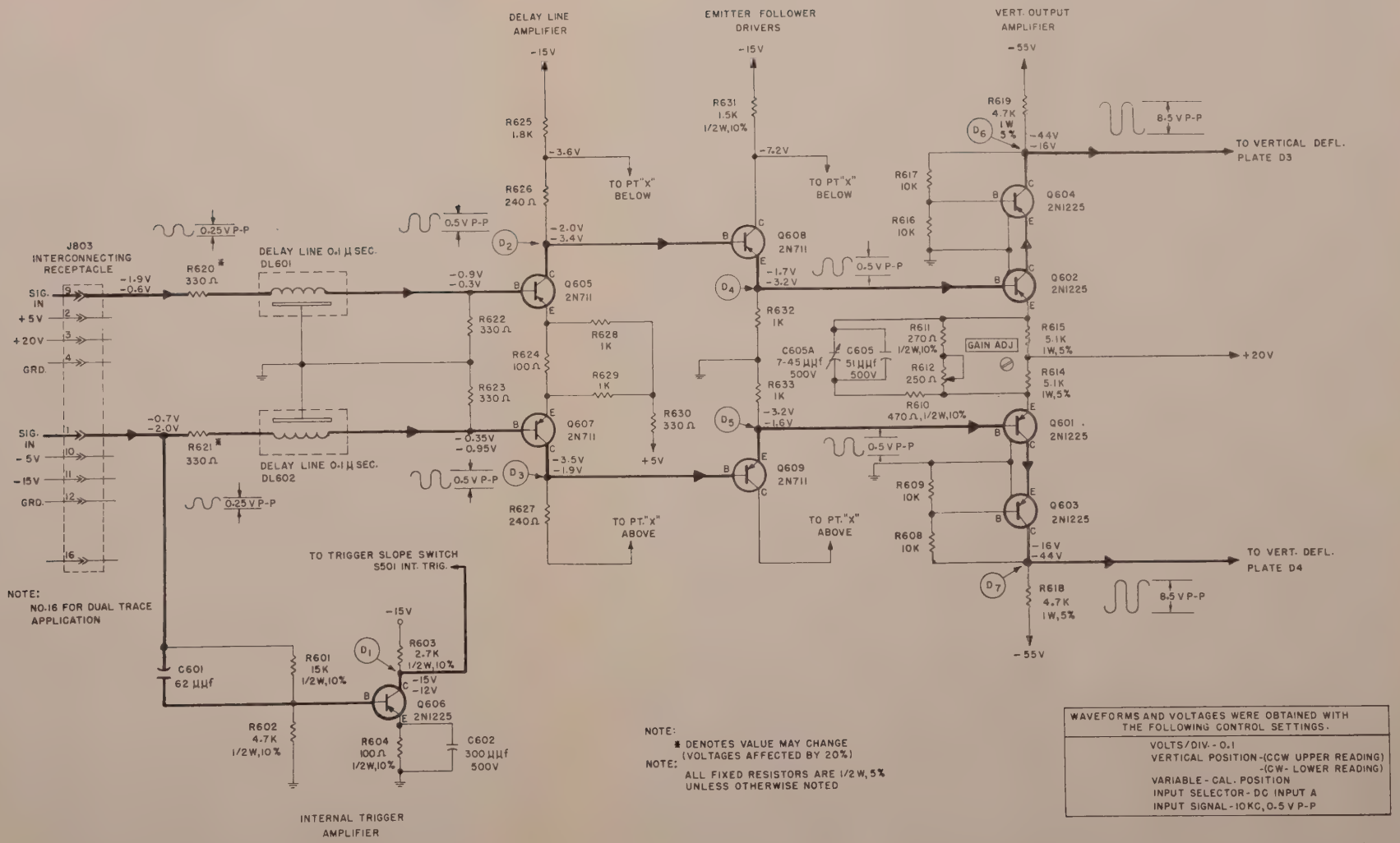


Figure 5-16. Oscilloscope AN/USM-117, Vertical Post Amplifier, Schematic Diagram

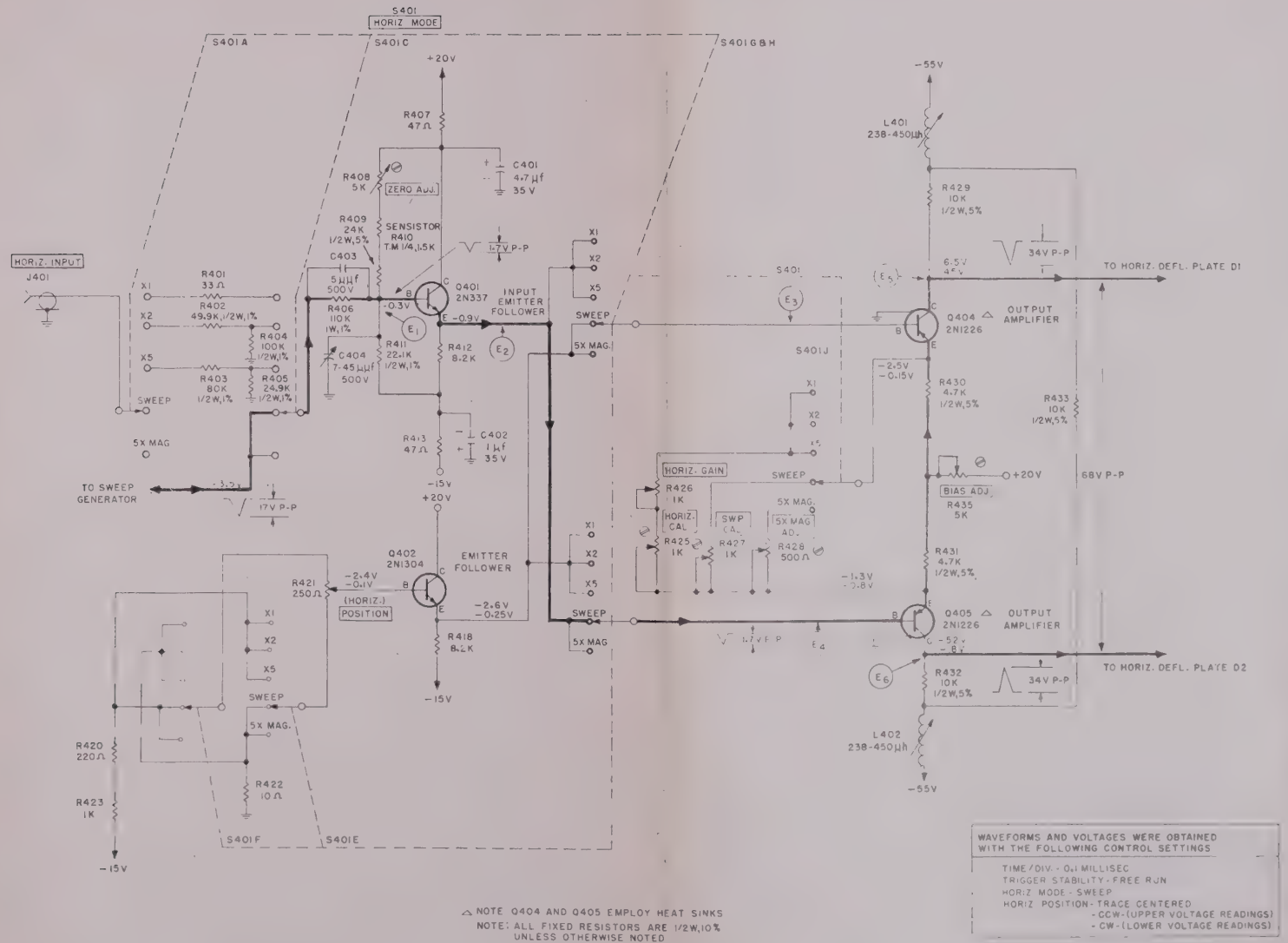
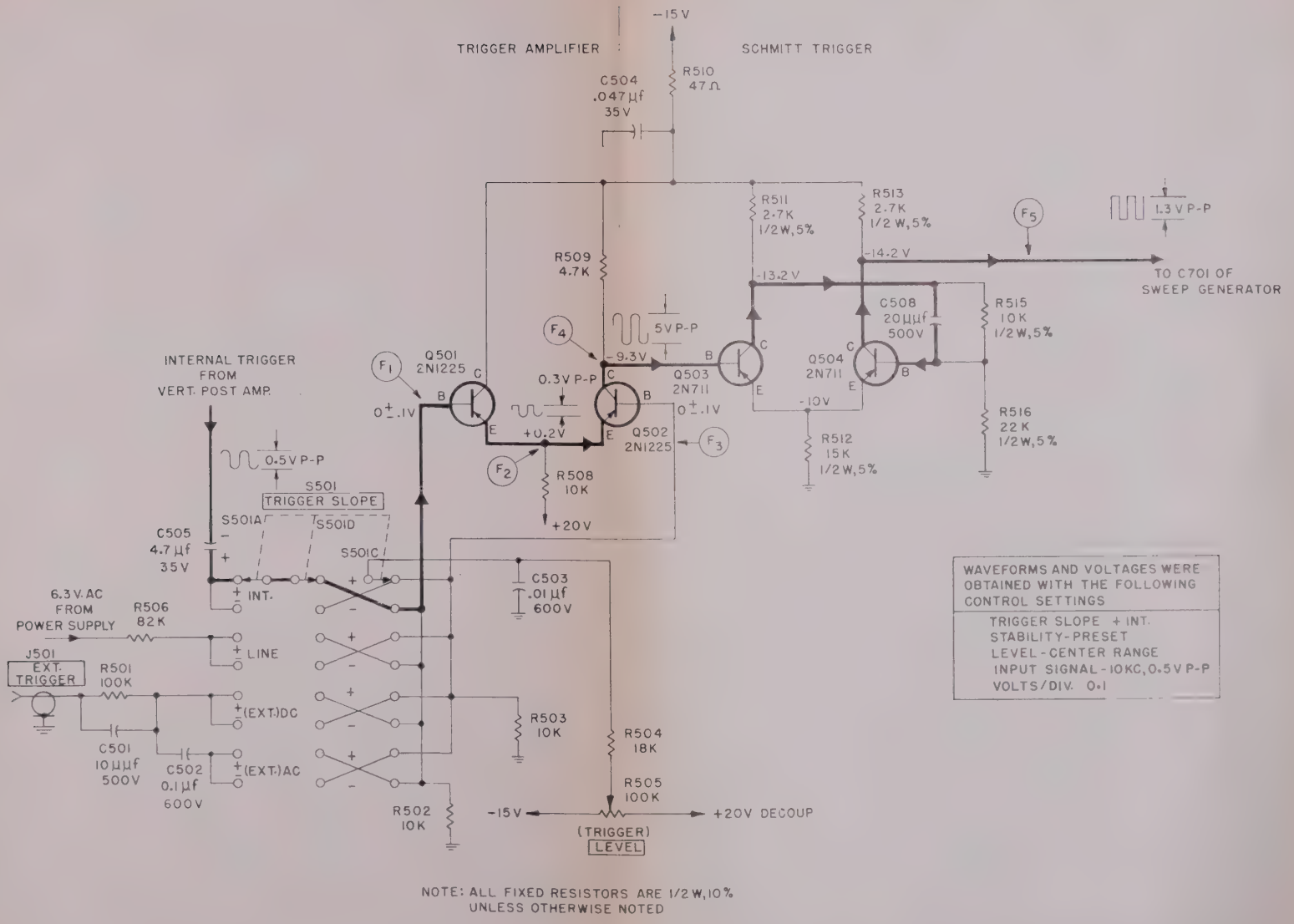
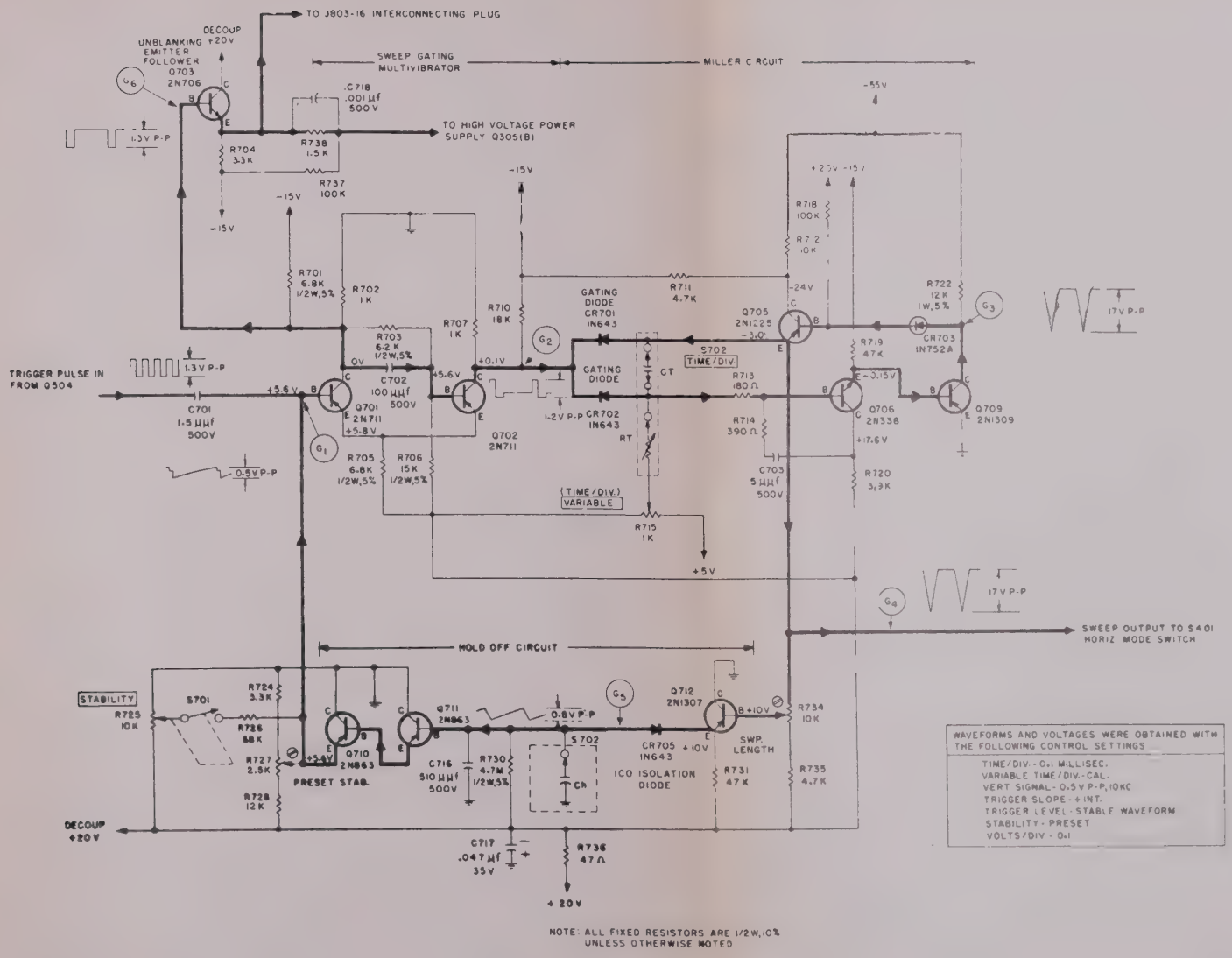


Figure 5-17. Oscilloscope AN/USM-117, Horizontal Amplifier, Schematic Diagram



NOTE: ALL FIXED RESISTORS ARE 1/2 W, 10% UNLESS OTHERWISE NOTED

Figure 5-18. Oscilloscope AN/USM-117, Sweep Trigger, Schematic Diagram



NOTE: ALL FIXED RESISTORS ARE 1/2W, 10% UNLESS OTHERWISE NOTED

Figure 5-19. Oscilloscope AN/USM-117, Sweep Generator, Schematic Diagram

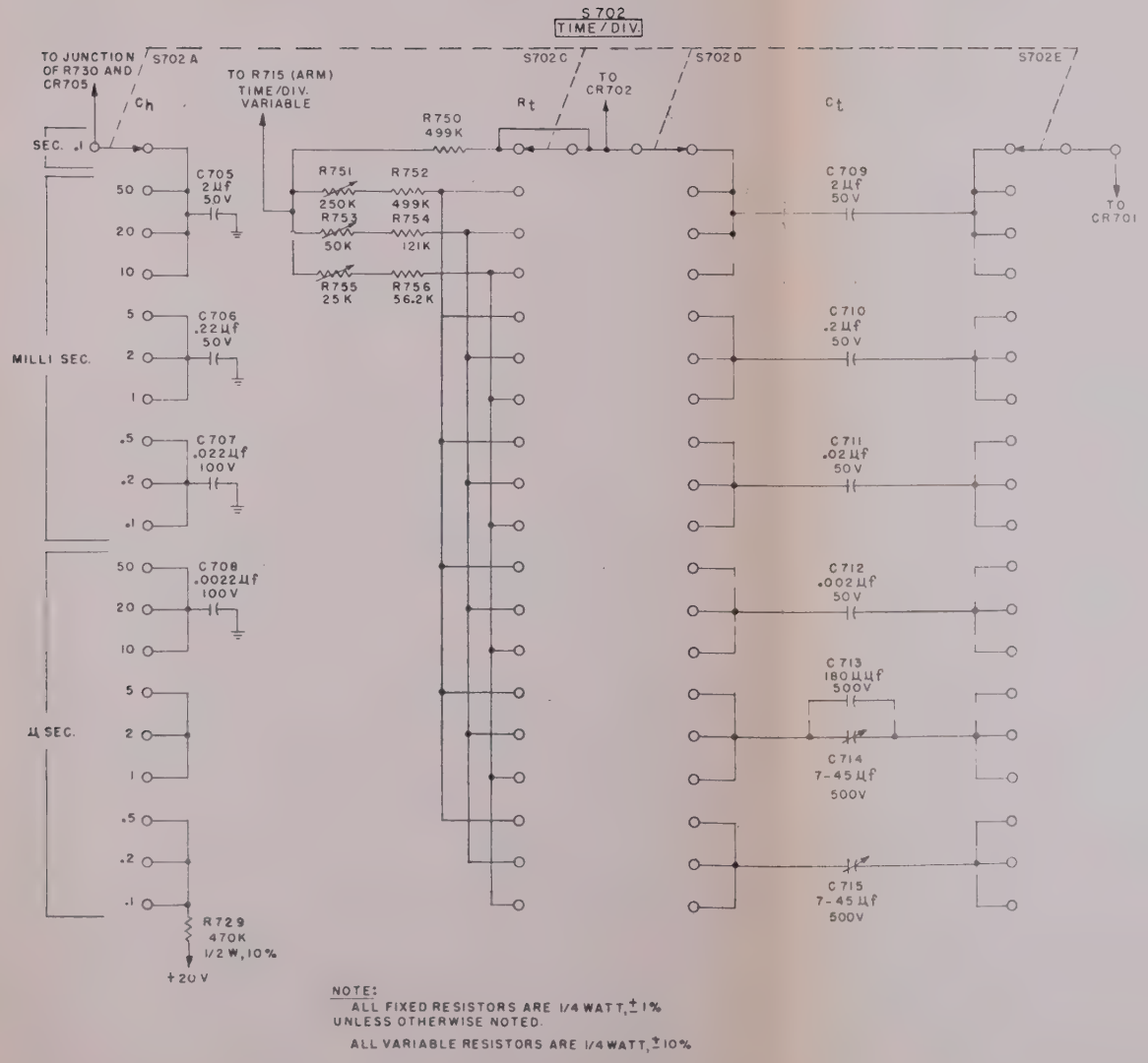


Figure 5-20. Oscilloscope AN/USM-117, Sweep Time Switch, Schematic Diagram

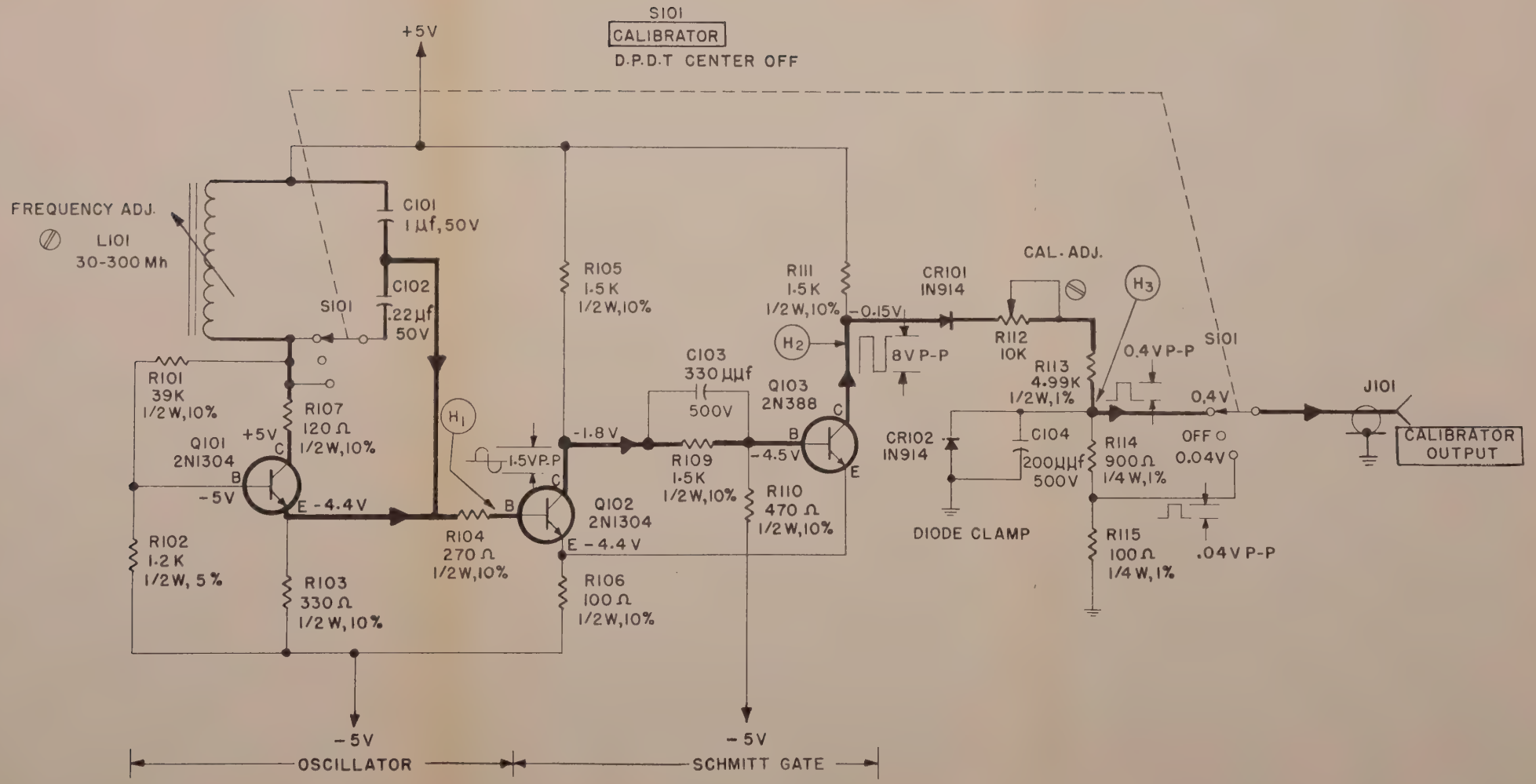


Figure 5-21. Oscilloscope AN/USM-117, Calibrator, Schematic Diagram

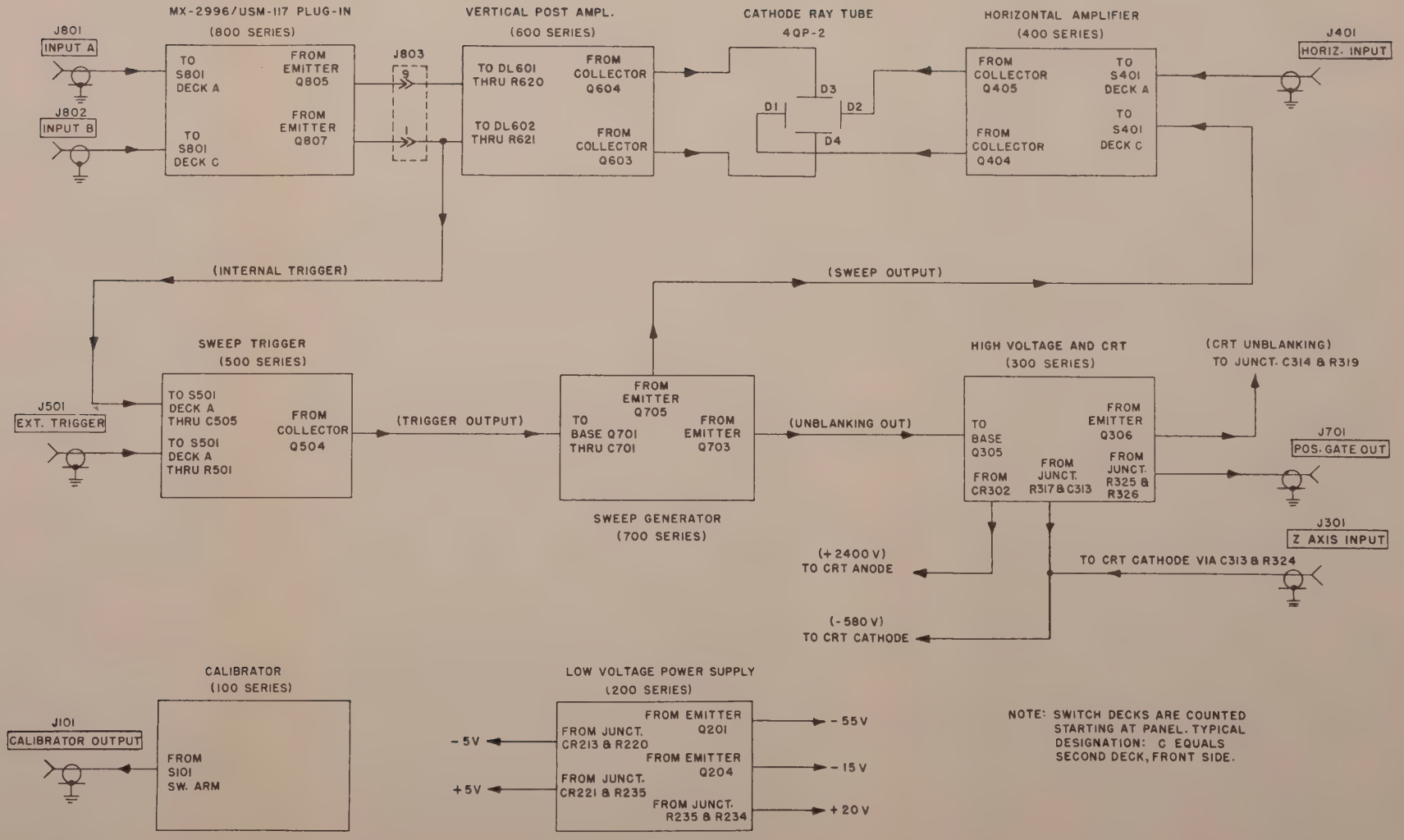


Figure 5-22. Oscilloscope AN/USM-117, Interconnecting Diagram

SECTION 6
SERVICE AND REPAIR

6-1. PREVENTIVE MAINTENANCE.

a. INTRODUCTION. — Maintenance procedures listed herein outline periodic tests which insure optimum operating efficiency and indicate preventive maintenance measures, when required, for Oscilloscope AN/USM-117. Tests are conducted both weekly and monthly. The average time required to complete these tests are given in paragraph 6-1b. Slight deviations from listed performance data may be caused by a small change in the established calibration. Larger variations may indicate an actual malfunction and thus require corrective measures.

b. MAINTENANCE SCHEDULE. — Table 6-1 gives the schedule of weekly and monthly maintenance checks. Weekly checks are performed by the operator; monthly checks are performed by maintenance personnel.

TABLE 6-1. ESTIMATED TIME REQUIRED TO PERFORM PREVENTIVE MAINTENANCE

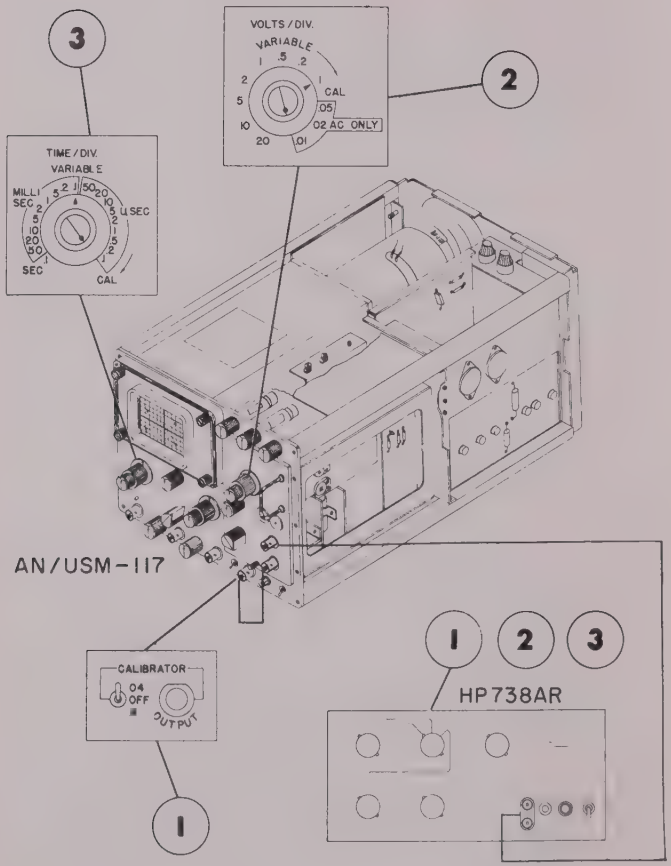
PERIODIC CHECKS	ESTIMATED TIME REQUIRED
Weekly	40 min
Monthly	12 min

c. RECORD OF FIELD CHANGES. — Field changes, if any, shall be recorded in table 6-2.

d. TEST EQUIPMENT. — Maintenance procedures listed herein are performed using the test equipment listed in table 5-1.

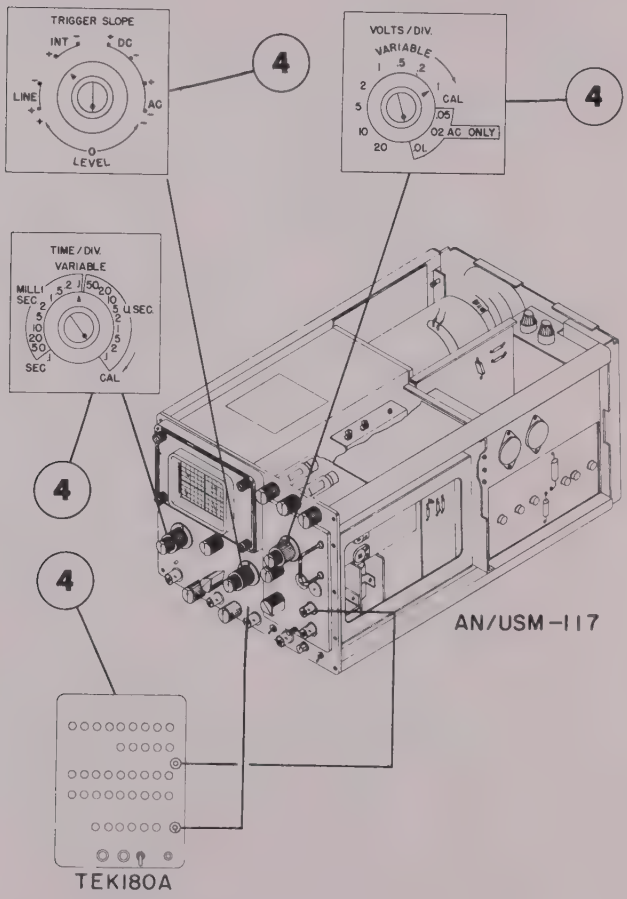
TABLE 6-2. RECORD OF FIELD CHANGES FOR PREVENTIVE MAINTENANCE

FLD CHG NO.	DATE COMPLETED	STEPS AFFECTED		FLD CHG NO.	DATE COMPLETED	STEPS AFFECTED	
		PAGE NO.	STEP NO.			PAGE NO.	STEP NO.


3
VOLTS / DIV.
VARIABLE
2
TIME / DIV.
VARIABLE
AN/USM-117
CALIBRATOR
.04
OFF
OUTPUT
1
1
2
3
HP738AR

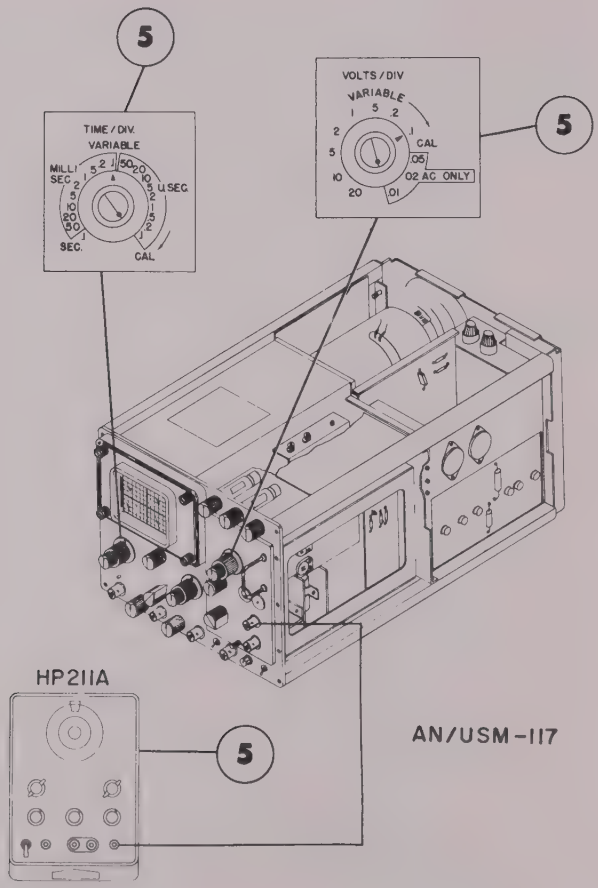
Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(1)	Record calibrator calibration	Connect precision calibrator to INPUT A-DC and apply 0.4V peak-to-peak sine wave (use TRACKING SCALE).	Crt screen	Record exact amplitude of waveform to be used as Reference Standard in following step.
(1.1)		Set CALIBRATOR to 0.4V and connect CALIBRATOR OUTPUT to INPUT B-DC.	Crt screen	Waveform same amplitude as step 1 within 2 percent.
(2)	Record vertical attenuator calibration	Using same equipment set up in step 1, set VOLTS/DIV switch to .01. Set precision calibrator to apply 0.05V peak-to-peak.	Crt screen	Sine wave waveform having amplitude of five divisions within 5 percent.
(2.1)		Set VOLTS/DIV switch to 0.2. Set output of precision calibrator to 1V peak-to-peak.	Crt screen	Waveform indentical to step 2.
(2.2)		Set VOLTS/DIV switch to 5. Set output of precision calibrator to 30V peak-to-peak.	Crt screen	Waveform identical to step 2, but having amplitude of six divisions within 5 percent.
(2.3)		Set VOLTS/DIV switch to 10. Set output of precision calibrator to 50V peak-to-peak.	Crt screen	Waveform identical to step 2.
(3)	Record sweep trigger	Connect precision calibrator to INPUT A-DC and apply 0.05V peak-to-peak sine wave. Set TIME/DIV switch to 0.5 MILLISEC.	Crt screen	Stable waveform, five cycles, one half division amplitude.


TRIGGER SLOPE
INT
DC
LINE
AC
LEVEL
4
VOLTS/DIV.
VARIABLE
CAL
.05
.02 AC ONLY
OL
4
TIME/DIV.
VARIABLE
MILLI SEC
μSEC
SEC
CAL
4
4
AN/USM-117
TEK180A

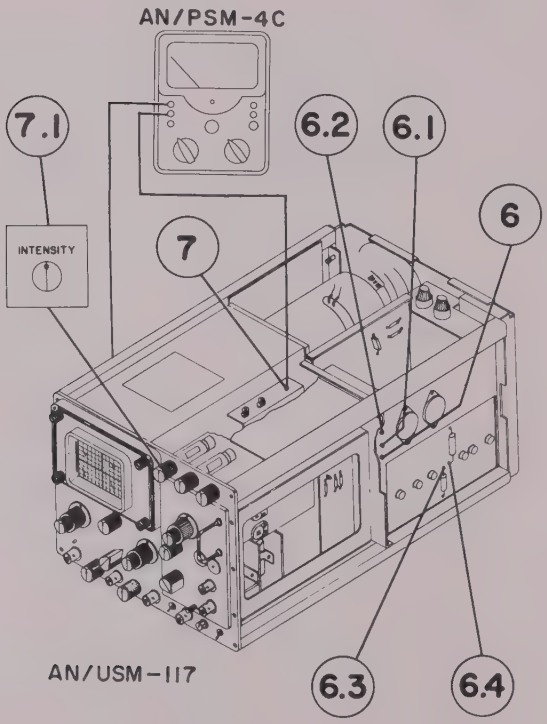
Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(4)	Record sweep timing calibration	Connect time mark generator to INPUT A-AC. Connect the TRIGGER OUT of the time mark generator to the EXT TRIGGER INPUT. Set other controls as follows: TRIGGER SLOPE to +AC; VOLTS/DIV for 2 div display; TRIGGER RATE at 10 cps; MARKER to 100 MILLISEC; TIME/DIV to 0.1 SEC	Crt screen	One marker every division. Maximum timing error: ±3 percent.
(4.1)		Set controls as follows: TRIGGER RATE at 100 cps; MARKER to 5 MILLISEC; TIME/DIV to 5 MILLISEC	Crt screen	One marker every division. Maximum timing error: ±3 percent.
(4.2)		Set controls as follows: TRIGGER RATE at at 1 kc; MARKER to 1 MILLISEC; TIME/DIV to 0.2 MILLISEC	Crt screen	One marker every fifth division. Maximum timing error: ±3 percent.
(4.3)		Set controls as follows: TRIGGER RATE at 100 kc; MARKER to 10 μSEC; TIME/DIV to 10 μSEC	Crt screen	One marker every division. Maximum timing error: ±3 percent.
(4.4)		Set controls as follows: TRIGGER RATE at 100 kc; MARKER to 1 μSEC; TIME/DIV to 1 μSEC	Crt screen	One marker every division. Maximum timing error: ±3 percent.
(4.5)		Set controls as follows: TRIGGER RATE at 100 kc; MARKER to 5 mc; TIME/DIV to 0.1 μSEC	Crt screen	Sine wave to cross its 50 percent rise point at every other division within ±3 percent.


5
TIME / DIV.
VARIABLE
MILLI SEC
SEC.
CAL
μSEC.
VOLTS / DIV
VARIABLE
CAL
.05
.02 AC ONLY
.01
5
HP211A
5
AN/USM-117

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(5)	Record vertical response (mid range)	Connect the 75-ohm OUTPUT of the square wave generator to INPUT A-DC. Set generator FREQUENCY to 5 kc. Set TIME/DIV to 50 μSEC Set amplitude controls of generator to display 5 div high waveform in each step. SET VOLTS/DIV to .01	Crt screen	Square wave with overshoot, slope, droop, etc. less than ±0.1 division.
(5.1)		Set VOLTS/DIV switch to 0.2	Crt screen	Waveform identical to step 5.
(5.2)		Set VOLTS/DIV switch to 5. Change generator OUTPUT from 75-ohm to 600-ohm.	Crt screen	Waveform identical to step 5.
(5.3)		Set VOLTS/DIV switch to 10	Crt screen	Waveform identical to step 5.


AN/PSM-4C
7.1
6.2
6.1
6
7
INTENSITY
AN/USM-117
6.3
6.4

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(6)	Check Low Voltage Supply	Connect multimeter to PJ203.	Multimeter	+20V ±0.5V
(6.1)		Connect multimeter to PJ202.	Multimeter	-15V ±0.5V
(6.2)		Connect multimeter to PJ201.	Multimeter	-55V ±1.5V
(6.3)		Connect multimeter to junction of CR213 and R220.	Multimeter	-5V ±0.5V
(6.4)		Connect multimeter to junction of CR221 and R235.	Multimeter	+5V ±0.5V
(7)	Check High Voltage Supply	Connect multimeter to PJ301	Multimeter	-580V ±10V
(7.1)		Vary setting of INTENSITY control over normal range.	Multimeter	Variation should not exceed approx. ±10V

TABLE 6-3. RECORD OF FIELD CHANGES FOR PERFORMANCE STANDARDS

FLD CHG NO.	DATE COMPLETED	PERFORMANCE STD TESTS AFFECTED		FLD CHG NO.	DATE COMPLETED	PERFORMANCE STD TESTS AFFECTED	
		PAGE NO.	STEP NO.			PAGE NO.	STEP NO.

6-2. MAINTENANCE STANDARDS.

a. INTRODUCTION. — Maintenance standards tests indicate whether or not the oscilloscope is operating within given limits of its maximum design capabilities. Maintenance standards tests should be performed after: (1) first time operation upon receipt of equipment, (2) new installation, (3) equipment overhaul, and (4) major field change. Tolerance figures given in the REFERENCE STANDARD column may not represent the absolute limits. In some cases, it is possible to exceed these limits to a small degree without having any degradation of performance. In general, however, consider these tests as the basis of an accurate judgment of the oscilloscope's performance.

b. RECORD OF FIELD CHANGES. — Field changes, if any, shall be recorded in table 6-3.

WARNING

Observe safety precautions given in paragraph 5-4 relating to high voltages found in this oscilloscope.

c. PREPARATION FOR MAINTENANCE STANDARDS TESTS. - Before performing the maintenance standards tests, it is necessary to complete all adjustments related to calibration of the oscilloscope, unless adjustments have been performed at a recent date. Details are given in paragraph 6-2e.

d. TEST EQUIPMENT. — Refer to table 5-1 for the list of test equipment necessary for performing adjustments. The plug-in extension cable shown in figure 5-1 is also required.

e. ADJUSTMENTS. — The following paragraphs describe the complete adjustment procedure related to the calibration of the

oscilloscope. Initial control settings should conform with those listed in table 5-2. Changes in settings will be noted in the individual procedures. Make all adjustments in the sequence listed; this is very important. Secure the lock nut on each control after adjustment.

f. LOW VOLTAGE POWER SUPPLY ADJUSTMENTS.

Adjust the following controls in the sequence listed, measuring voltage at the test points indicated. Refer to figure 6-6 (Sheet 1).

Supply Voltage	Control	Test Point
+ 20V	R233	PJ203 ★5
- 55V	R205	PJ201 ★1
- 15V	R215	PJ202 ★2

g. HIGH VOLTAGE SUPPLY AND CRT ADJUSTMENTS.

(1) -580V ADJUSTMENTS. — Adjust HV ADJ control R311 (figure 6-6, sheet 1), until the voltage at test point 6 (PJ301) is equal to -580V.

(2) CRT ALIGNMENT. — Advance the STABILITY control to FREE RUN and center the trace vertically. Loosen the mounting strap at the base of crt. Rotate the crt a few degrees, carefully holding it by the base, until the trace is aligned with the center graticule line. Fasten strap.

(3) GEOMETRY ADJUSTMENT. — Apply a 100 kc signal from the sine wave generator to the vertical INPUT. Set the TIME/DIV switch to .1 MILLISEC. Set AMPLITUDE control of generator and VOLTS/DIV switch to offer eight division high display. Adjust INTENSITY control for average brightness. Adjust GEOM control R316 (figure 6-2) until the displayed raster pattern has a rectangular shape.

(4) SHIELD ADJUSTMENT. — Remove protective cap from rear of crt socket and measure voltage from pin 9 to ground.

Adjust SHIELD control R314 (figure 6-2) until the meter reads - 25V. Replace cap on crt socket. Using the equipment set-up of paragraph 6-2g (3), further trim the adjustment of the SHIELD control as follows: reduce the frequency of the generator to display about six full cycles. Trim the control adjustment for best overall or edge to edge focus of the waveform. Slight readjustment of the FOCUS and ASTIG controls may be necessary.

h. HORIZONTAL AMPLIFIER ADJUSTMENTS.

(1) ZERO ADJUSTMENT. — Set the HORIZ MODE switch to X1. Set the vtvm to 1 VOLT DC; adjust ZERO ADJ control of vtvm with test leads shorted. Connect test leads to HORIZ INPUT. Adjust ZERO ADJ control R408 (figure 6-12) until meter indicates zero volts.

(2) SENSITIVITY ADJUSTMENT. — Set the HORIZ MODE switch to X1 and the HORIZ GAIN control fully clockwise. Connect the output of the voltage calibrator to the HORIZ INPUT. Set the output of the calibrator to 3 volts peak-to-peak. Adjust HORIZ CAL control R425 (figure 6-12) for 6 divisions of deflections with the trace centered.

(3) SQUARE WAVE ADJUSTMENTS. - Connect output of the square wave generator to HORIZ INPUT using a 75-ohm cable. Connect 600-ohm output of the generator to EXT TRIGGER INPUT. Connect a clip lead jumper wire from the junction of the SWP LENGTH control R734 and resistor R735 (mounted between this control and printed circuit board) over to the vertical INPUT. Set controls as follows: TRIGGER SLOPE to +AC EXT, HORIZ MODE to X1 and TIME/DIV to 10 μSEC. Adjust 75-ohm output of generator to give five divisions of horizontal deflection. Advance 600-ohm output control half way. Set frequency of generator to 25 kc. Set VOLTS/DIV switch to provide a two cycle square wave presentation (having vertical time base) on screen.

Adjust C404 (figure 6-12) for optimum square wave response with no overshoot or undershoot. Increase the frequency of the generator to 100 kc. Set TIME/DIV switch to 2 μSEC. Adjust L401 and L402 (figure 6-4) for best square wave. Alternate between the coils, adjusting each by a small amount until the total adjustment is complete.

i. SWEEP GENERATOR ADJUSTMENTS.

(1) GENERAL. — When making sweep timing adjustment, avoid parallax to obtain accurate calibration settings. Accurate readings may be obtained by aligning your eye at a right angle to the graticule at the point of measurement.

(2) AMPLIFIER BIAS. — Connect the MARKER OUT of the time mark generator to the verticle INPUT. Connect the TRIGGER OUT of this generator to the TRIGGER INPUT of the equipment. Set the TRIGGER RATE switch of the generator to 100 kc.

Switch on the 5 mc sine wave output. Set the TRIGGER SLOPE switch to +AC, the TIME/DIV switch to 0.1 μsec, the VOLTS/DIV and VARIABLE controls for six divisions of vertical deflection and the STABILITY and LEVEL controls for a stable pattern. Adjust BIAS ADJ controls R435 (figure 6-12) for optimum linearity. That is, uniform spacing of individual cycles with minimum compression or distortion. Check linearity through the entire range of horizontal positioning. Do not consider the accuracy of sweep timing at this time. Recheck horizontal sensitivity as outlined in paragraph 6-2h (2).

(3) PRESET STABILITY. — Apply a 1 kc, 0.5-volt peak-to-peak signal from the square wave generator to the vertical INPUT and EXT TRIGGER INPUT using a BNC tee connector. Set the TRIGGER SLOPE switch to + AC and the STABILITY to PRESET. Adjust PRESET STAB control R727 (figure 6-15) until the waveform disappears; then advance control until it reappears and becomes stable. Adjust the LEVEL control during the procedure for most stable triggering point.

(4) SWEEP LENGTH. — Set the TIME/DIV switch to 0.1 MILLISEC and the STABILITY control to FREE RUN. Center the trace on the screen and adjust SWP LGTH control R734 (figure 6-15) for a trace length of 10.5 divisions.

(5) BASIC TIMING. — Using the equipment setup and control settings described in paragraph 6-2i (2), set the TRIGGER RATE

switch of the generator to 10 cps and switch on the 100 MILLISEC markers. Set the TIME/DIV switch to 0.1 SEC and the VOLTS/DIV switch to display a waveform about two divisions high. Align the first marker with the left graticule line and adjust SWP CAL control R427 (figure 6-12) until each marker falls directly on each vertical graticule line over the 10 division area. Repeat SWEEP LENGTH adjustment, paragraph 6-2i (4).

(6) SEQUENCE TIMING. — Set the TIME/DIV switch to 0.1 MILLISEC. Set the TRIGGER RATE switch of the generator to 10 kc and switch on the 100 μsec markers. Adjust R755 marked "1" (figure 6-3) until each marker coincides with a vertical line on the graticule.

Set the TIME/DIV switch to 0.2 MILLISEC. Set the TRIGGER RATE switch of the generator to 1 kc and switch on the 1 MILLISEC markers. Adjust R753 marked "2" (figure 6-3) until the first, center, and last markers fall on the first, center, and last vertical graticule lines.

Set the TIME/DIV switch to 0.5 MILLISEC. Leave the TRIGGER RATE switch of the generator set at 1 kc and switch on the 500 μsec markers. Adjust R751 marked "5" (figure 6-3) until each marker coincides with a vertical line on the graticule. To obtain proper alignment in these procedures, it may be necessary to vary the horizontal POSITION control somewhat.

(7) FAST SWEEP TIMING. — Set the TIME/DIV switch to 1 μsec. Set the TRIGGER RATE switch of the generator to 100 kc and switch on the 1 μsec markers. Adjust C714 (figure 6-2) until each marker coincides with a vertical line on the graticule.

Set the TIME/DIV switch to 0.1 μsec. Leave the TRIGGER RATE switch set at 100 kc and switch on the 5 mc sine wave output from the generator. Position the upper tip of the first sine wave to the left hand graticule. Adjust C715 until the upper tip of each sine wave coincides with every other vertical line on the graticule.

After making each fast sweep timing adjustment check the two previous ranges. It may be desirable to make an adjustment which would distribute any existing error equally among the ranges.

(8) 5X MAGNIFIER. — Set the TIME/DIV switch to 0.1 MILLISEC and the HORIZ MODE to 5X MAG. Set the TRIGGER RATE switch of the generator to 10 kc and switch on the 100 μsec markers. Adjust 5X MAG ADJ control R428 (figure 6-12) until the first, center, and last markers fall on the first, center and last vertical graticule lines. Check timing through entire range of horizontal positioning.

j. VERTICAL SENSITIVITY.

(1) PRELIMINARY. — Balance Vertical Plug-in MX-2996/USM-117 as outlined in paragraph 3-3b. Use the differential mode (a-b) of test oscilloscope; see table 5-1 Set its VARIABLE control to CAL and check calibration on 0.1 VOLT/CM range of channels A and B. Connect one set of differential test leads to test point C_6; connect the other set to C_7 (see test points, figure 5-7). Apply a 0.1-volt peak-to-peak signal from voltage calibrator to vertical INPUT of unit under test. Set the VOLTS/DIV switch to 0.01. Display about three cycles of waveform. Adjust the LEVEL control for a stable pattern.

(2) INDICATOR OS-106/USM-117. — Rotate the VARIABLE control of the unit under test until the amplitude of the waveform viewed on the test oscilloscope is exactly four centimeters high. If waveform will not reduce to this height, lower the output of the voltage calibrator to 0.05 volts peak-to-peak. With exactly four centimeters displayed on the test oscilloscope, adjust GAIN ADJUST control R612 (figure 6-1) until the waveform viewed on the unit under test is exactly four divisions high (0.4 volts peak-to-peak). Remove leads of test oscilloscope.

(3) VERTICAL PLUG-IN MX-2996/USM-117. — Return the VARIABLE control of the unit under test to the CAL position.

With 0.05-volt peak-to-peak applied from the voltage calibrator, adjust .01V ADJ control R829 (figure 6-20) until the waveform viewed on the unit under test is exactly five divisions high. Rebalance plug-in as outlined in paragraph 3-3b.

k. VERTICAL SQUARE WAVE RESPONSE.

(1) BASIC ADJUSTMENT. — Set the VOLTS/DIV switch to 0.01. Connect the 75-ohm output of the square wave generator to the vertical INPUT, using a 75-ohm cable. Set the FREQUENCY dial of the generator to 5 kc and its ATTEN-AMPLITUDE controls to offer a five division high waveform on screen. Set the TIME/DIV switch to display five or more cycles of waveform. Adjust C817 (figure 6-20) for optimum square wave response with no overshoot or undershoot.

(2) HIGH FREQUENCY PEAKING. — Increase the frequency of the generator to 250 kc. Set the TIME/DIV switch to display several cycles of waveform. Adjust C820 (figure 6-20) and C605A (figure 6-1) for optimum square wave response with no overshoot or undershoot. Since C820 and C605A peak in slightly different areas of the waveform, this dual adjustment is not difficult to make. Rotate the VARIABLE control full counter clockwise and increase the output of the generator to maintain the original amplitude. Adjust C822 (figure 6-20) for optimum square wave response. Since the adjustments of C822 and C820 interact somewhat, it may be necessary to make these adjustments one or two times.

(3) ATTENUATOR ADJUSTMENTS. — Return the frequency of the generator to 5 kc and display several cycles of the waveform. Make the specified adjustments for a correctly compensated waveshape (no overshoot or undershoot) on the following VOLTS/DIV ranges: 0.02-C804; 0.05-C806; 0.1-C815; 0.2-C803; 0.5-C805; 1-C809; 2-none; 5-none; 10-C812; 20-none.

After making each adjustment, place a small (approx 4-1/2 in. x 4-1/2 in.) aluminum plate over the adjustment area to simulate the shielding effect of the instrument case. Trim the adjustment accordingly. In the higher VOLTS/DIV ranges, it will be necessary to transfer to the 600-ohm output of the

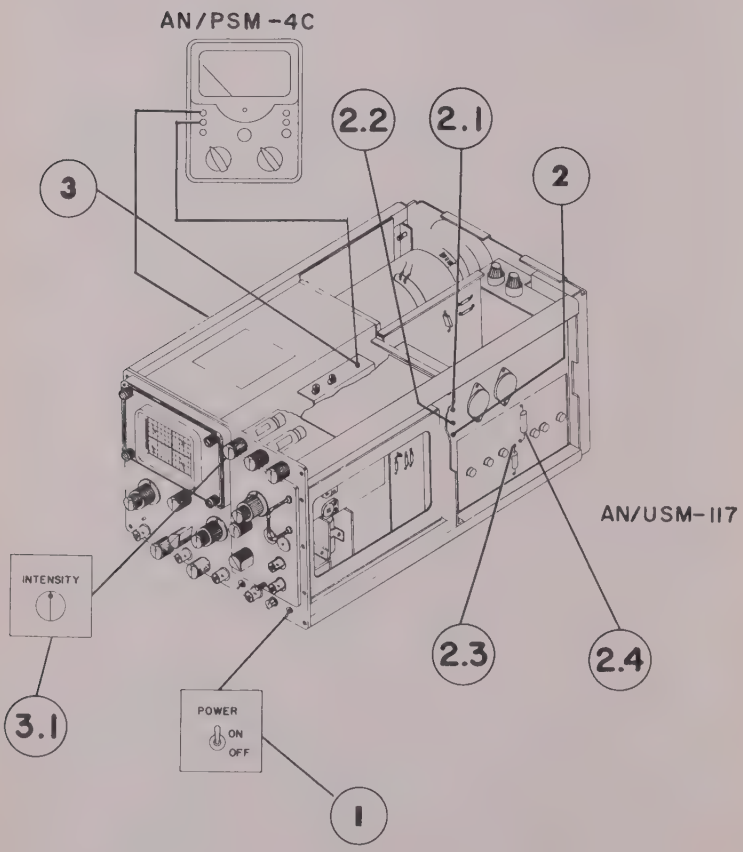
generator. Adjustments of C815 and C814 (listed below) require the use of the extension cable illustrated in figure 5-1. The attenuator adjustment variable capacitors may be locked tight due to their Humi-Seal coating. If so, apply a coat of thinner (Xylol or Triad) to soften the coating. Allow thinner to dry completely before making adjustments.

To make input capacity adjustments, proceed as follows: connect probe to vertical INPUT and make basic probe adjustment as outlined in paragraph 3-3h with VOLTS/DIV switch set to .01. With the probe properly adjusted, set the VOLTS/DIV switch to .1, connect the probe to the 600-ohm output of the square wave generator (set to 1 kc) and adjust C814 for best square wave response. Adjust output of square wave generator to maintain five division high display. Set the VOLTS/DIV switch to 1 and adjust C808 for best square wave response. Set the VOLTS/DIV switch to 10 and adjust C811 for best square wave response. All adjustments are shown in figure 6-20, except C814 and C815 which is shown in figure 6-21. Recheck all adjustments when the instrument is inserted in its case.

1. CALIBRATOR ADJUSTMENTS.

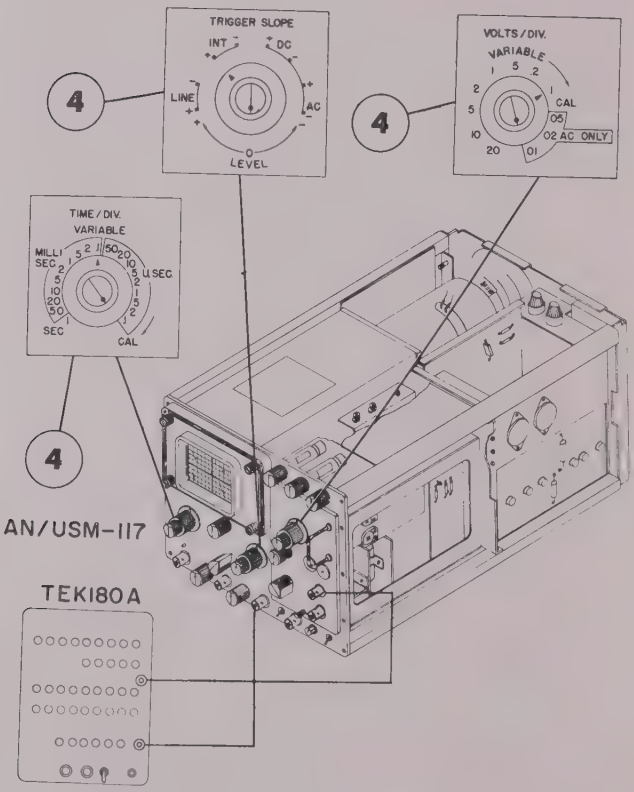
(1) FREQUENCY. — Set the VOLTS/DIV switch to 0.1 and the CALIBRATOR output switch to 0.4. Connect a short cable between the CALIBRATOR OUTPUT and the vertical INPUT. Set the TIME/DIV switch to 0.1 MILLISEC. Adjust FREQ ADJ control L101 (figure 6-3) until one cycle of the waveform is exactly 10 division long or 1.0 MILLISEC.

(2) AMPLITUDE. — Connect the output of the voltage calibrator to vertical INPUT A-DC. Connect the CALIBRATOR OUTPUT to INPUT B-DC. Set the voltage calibrator to 0.4 volt peak-to-peak on the TRACKING position of the generator. Set the CALIBRATOR OUTPUT to 0.4 volt peak-to-peak and the VOLTS/DIV switch to 0.1. Adjust CAL ADJ control R112 (figure 6-13) until the waveform amplitude at INPUT B is to equal that of INPUT A.


AN/PSM-4C
2.2
2.1
2
3
AN/USM-117
INTENSITY
2.3
2.4
3.1
POWER
ON
OFF
1

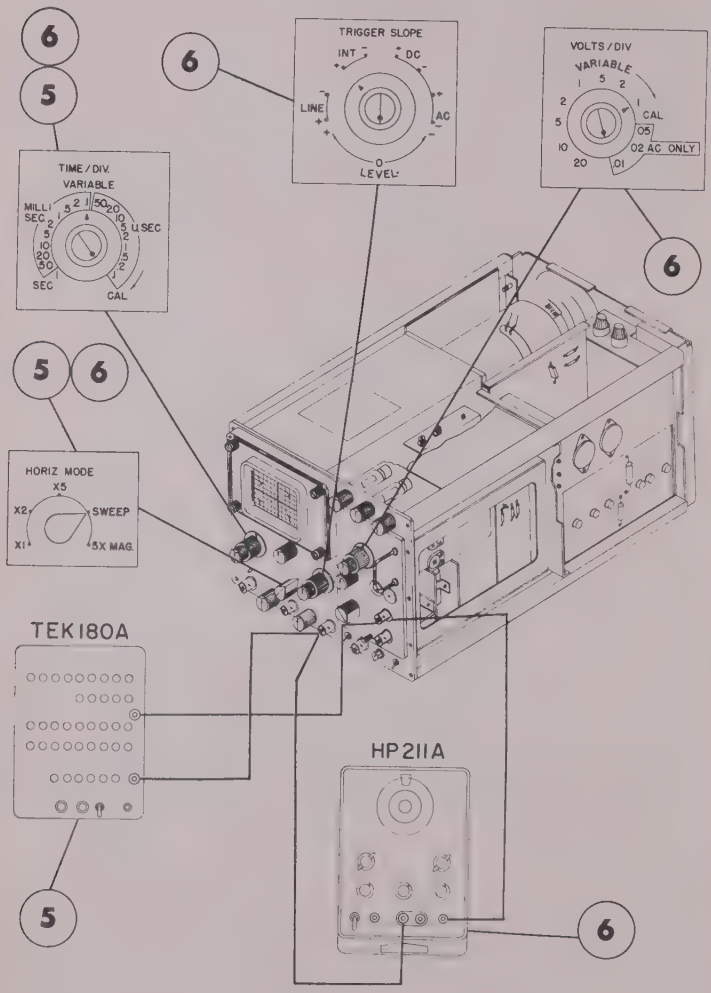
Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(1)	Verify power line operation	Turn POWER switch to ON.	Pilot Lamp	Pilot Lamp glows.
(2)	Check low voltage supply	Connect multimeter to PJ203	Multimeter	+20V ±0.5V
(2.1)		Connect multimeter to PJ202	Multimeter	-15V ±0.5V
(2.2)		Connect multimeter to PJ201	Multimeter	-55V ±1.5V
(2.3)		Connect multimeter to junction of CR213 and R220	Multimeter	-5V ±0.5V
(2.4)		Connect multimeter to junction of CR221 and R235	Multimeter	+5V ±0.5V
(3)	Check high voltage supply	Connect multimeter to PJ301	Multimeter	-580V ±10V
(3.1)		Vary setting of INTENSITY control over normal range.	Multimeter	Variation should not exceed approx ±10V.


TRIGGER SLOPE
INT
DC
LINE
AC
0
LEVEL
VOLTS/DIV.
VARIABLE
CAL
.05
.02 AC ONLY
.01
TIME/DIV.
VARIABLE
MILLI SEC
μSEC
SEC
CAL
4
4
4
AN/USM-117
TEK180A

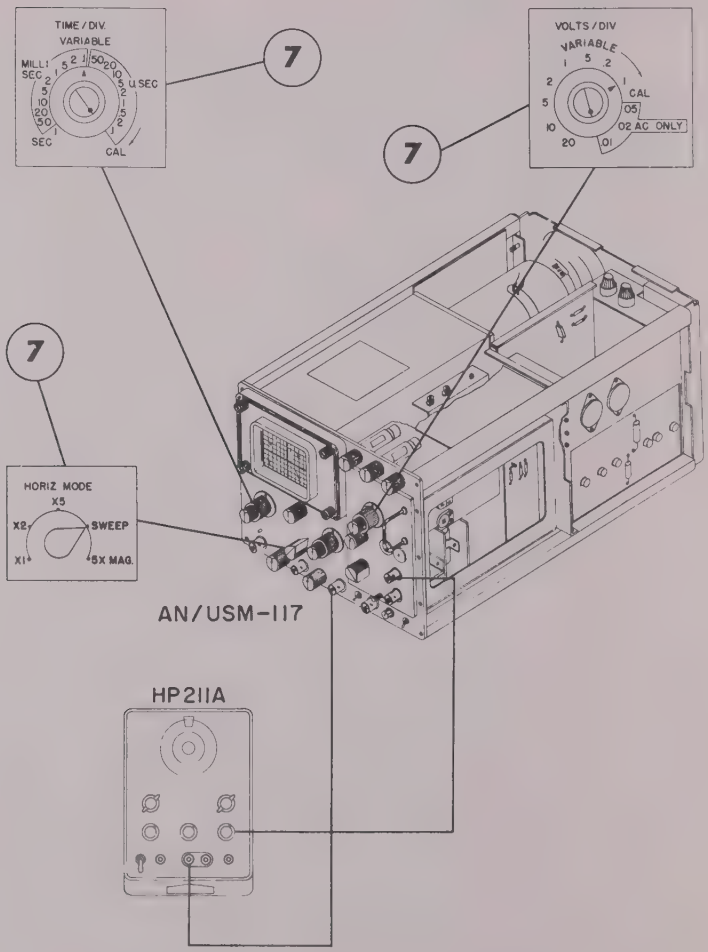
Operation Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(4)	Check sweep timing	Connect time mark generator to INPUT A-AC. Connect the TRIGGER OUT of the Time Mark generator to the EXT TRIGGER INPUT. Set other controls as follows: TRIGGER SLOPE +AC; VOLTS/DIV -2 div display; TRIGGER RATE -10 cps; MARKER -100 MILLISEC; TIME/DIV 0.1 SEC.	Crt screen	One marker every division Maximum timing error: ±3 percent
(4.1)		TRIGGER RATE -1 kc MARKER - 1 MILLISEC TIME/DIV - 1 MILLISEC	Crt screen	One marker every division. Maximum timing error: ± 3 percent
(4.2)		TRIGGER RATE -10 kc MARKER -100 μSEC TIME/DIV -20 μSEC	Crt screen	One marker every fifth division. Maximum timing error: ±3 percent
(4.3)		TRIGGER RATE -100 kc MARKER - 5 μSEC TIME/DIV - 5 μSEC	Crt screen	One marker every division. Maximum timing error. ±3 percent.
(4.4)		TRIGGER RATE -100 kc MARKER -5mc TIME/DIV -0.2 μSEC	Crt screen	Sine wave to cross its 50 percent rise point at every division within 3 percent.


6
5
6
TRIGGER SLOPE
INT
DC
LINE
AC
LEVEL
VOLTS/DIV
VARIABLE
CAL
.05
.02 AC ONLY
.01
TIME/DIV.
VARIABLE
MILLI SEC
μSEC
SEC
CAL
6
5 6
HORIZ MODE
X5
X2
SWEEP
X1
.5X MAG.
TEK180A
HP211A
5
6

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(5)	Check sweep expansion	Using equipment set up in step 4, set controls as follows: HORIZ MODE-5X MAG; TRIGGER RATE- 1 kc; MARKER -1 MILLISEC; TIME/DIV -5 MILLISEC; Position display through its entire horizontal range.	Crt screen	One marker every division. Maximum timing errors ±3 percent.
(6)	Check vertical response (high range)	Connect the 75-ohm OUTPUT of the square wave generator to INPUT A-DC. Connect 600-ohm OUTPUT of generator to EXT TRIGGER INPUT. Set generator frequency to 1 mc. Set amplitude controls of 75-ohm OUTPUT to display 5 div high waveform. Set 600-ohm OUTPUT control mid-way. Set other controls as follows: TRIGGER SLOPE +AC; VOLTS/DIV -.01; TIME/DIV -0.5 μSEC; HORIZ MODE -5X MAG.	Crt screen	Rise time of square wave should measure 0.074 μSEC. or less between 10 and 90 percent amplitude points.


TIME / DIV.
VARIABLE
MILLI SEC
u SEC
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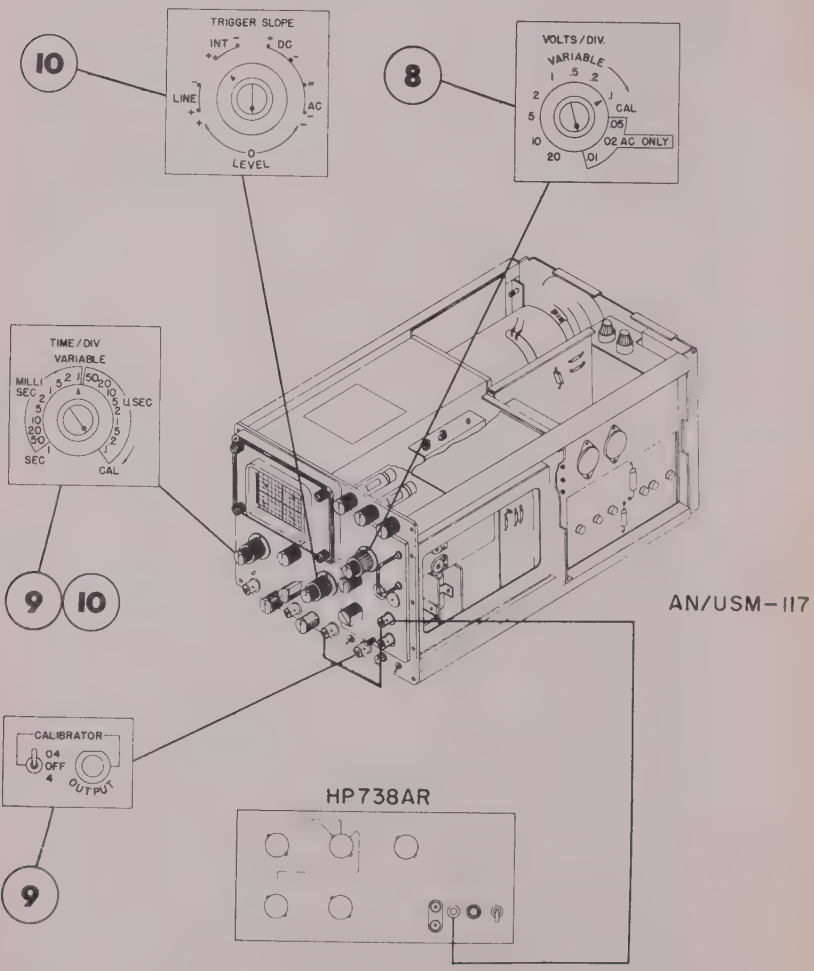
CAL
7
VOLTS / DIV
VARIABLE
CAL
05
02 AC ONLY
01
7
7
HORIZ MODE
X5
X2
SWEEP
X1
5X MAG.
AN/USM-117
HP211A

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(7)	Check vertical response (mid range)	Using equipment set up in step 6, change the frequency of the generator to 5 kc. Adjust generator output to display 5 div. high waveform. Also change to the following control settings: VOLTS/DIV - .01 TIME/DIV - 50 μSEC HORIZ MODE - SWEEP	Crt screen	Square wave with overshoot slope, droop etc, less than ±0.1 division.
(7-1)		Set VOLTS/DIV switch to 0.5	Crt screen	Waveform identical to step 7.
(7.2)		Set VOLTS/DIV switch to 2. Interchanged 75-ohm and 600-ohm OUTPUTS.	Crt screen	Waveform identical to step 7.
(7.3)		Set VOLTS/DIV switch to 20	Crt screen	Waveform reduced in amplitude (refer to step 7), but with no noticeable overshoot, slope, droop etc.


10
TRIGGER SLOPE
INT
DC
LINE
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0
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8
VOLTS/DIV.
VARIABLE
CAL
05
02 AC ONLY
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TIME/DIV
VARIABLE
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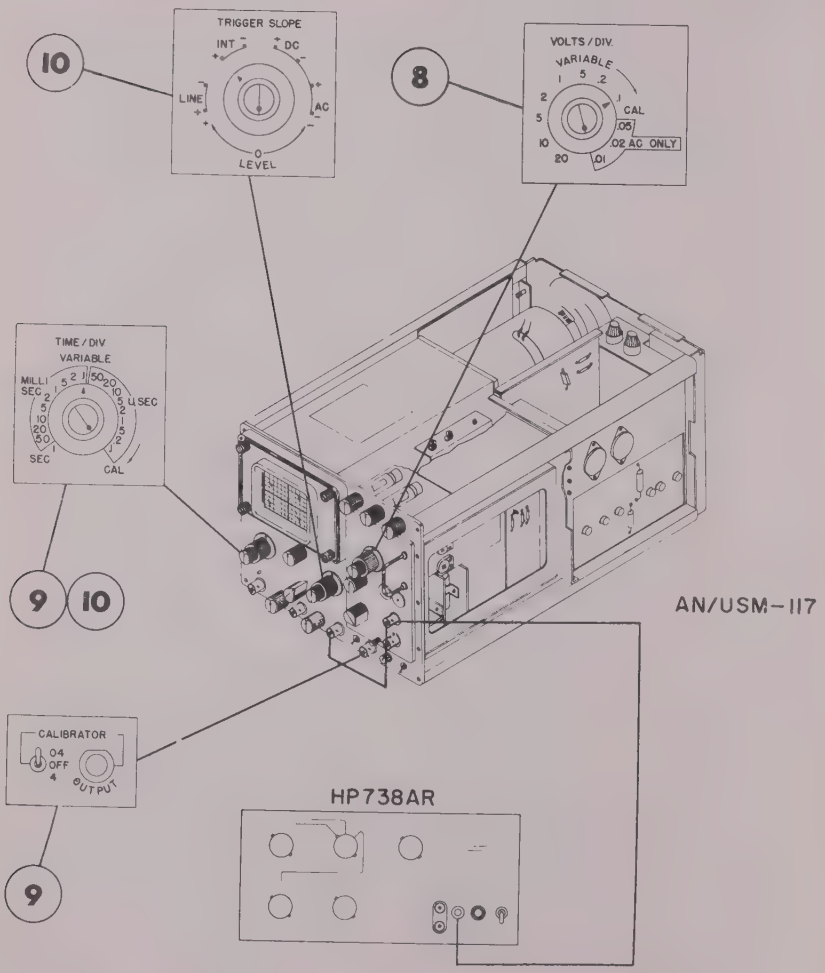
μSEC
SEC
CAL
9
10
AN/USM-117
CALIBRATOR
04
OFF
4
OUTPUT
9
HP738AR

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(8)	Check vertical attenuator calibration	Connect precision calibrator to INPUT A-DC and apply .05V peak-to-peak. Set VOLTS/DIV switch to .01.	Crt screen	Sine wave waveform having amplitude of five divisions within 5 percent.
(8.1)		Set VOLTS/DIV switch to 0.5. Set output of precision calibrator to 3V peak-to-peak.	Crt screen	Sine wave waveform having amplitude of six divisions within 5 percent.
(8.2)		Set VOLTS/DIV switch to 2. Set output of precision calibrator to 10V peak-to-peak.	Crt screen	Waveform identical to step 8.
(8.3)		Set VOLTS/DIV switch to 20. Set output of precision calibrator to 100V peak-to-peak.	Crt screen	Waveform identical to step 8.
(9)	Check calibrator amplitude, frequency, and rise time.	Connect precision calibrator to INPUT A-DC and apply 0.4V peak-to-peak sine wave (use TRACKING scale).	Crt screen	Record exact amplitude of waveform to be used as Reference Standard in following step.
(9.1)		Set CALIBRATOR to 0.4V, and connect CALIBRATOR OUTPUT to INPUT B-DC.	Crt screen	Waveform same amplitude as step 9 within 2 percent.
(9.2)		Measure period (time of one cycle) of waveform at INPUT B-DC.	Crt screen	Time of one cycle should measure 1 MILLISEC. ±10 percent.


10
TRIGGER SLOPE
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VOLTS / DIV.
VARIABLE
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.05
.02 AC ONLY
.01
TIME / DIV
VARIABLE
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μSEC
SEC
CAL
9
10
AN/USM-117
CALIBRATOR
OFF
OUTPUT
9
HP738AR

Operating Conditions and Control Settings:
Same settings as given in table 5-2 unless otherwise noted.

STEP NO.	ACTION REQUIRED	PRELIMINARY ACTION	READ INDICATION ON	REFERENCE STANDARD
(9.3)		Increase TIME/DIV switch to μSEC. Measure rise time of waveform at INPUT B-DC.	Crt screen	Rise time should measure less than 1.5 μSEC. between 10 and 90 percent amplitude points.
(10)	Check sweep trigger (internal and external)	Connect precision calibrator to INPUT A-DC and apply 0.05V peak-to-peak sine wave. Set TIME/DIV switch to 0.5 MILLISEC.	Crt screen	Stable waveform, five cycles, one half division amplitude.
(10.1)		Add short cable from INPUT A to EXT. TRIGGER INPUT using BNC tee. Set TRIGGER SLOPE switch to +AC. Increase output of precision calibrator to 1.0V peak-to-peak set VOLTS/DIV switch to 0.5.		Stable waveform, five cycles, two divisions of amplitude.

6.3 REPAIR

a. FAILURE, PERFORMANCE, AND OPERATIONAL REPORTS. — Include the following note as the first paragraph in Section 5:

NOTE

The Bureau of Ships no longer requires the submission of failure reports for all equipments. Failure Reports and Performance and Operational Reports are to be accomplished for designated equipments (refer to EIMB) to the extent required by existing directives. All failures shall be reported for those equipments requiring Failure Reports.

Always keep a supply of failure report forms on board. You can get them from the nearest District Publications and Printing Office.

b. TUNING AND ADJUSTMENT. — Adjustment instructions are given in paragraph 6-2e.

c. REMOVAL OF PARTS AND SUBASSEMBLIES.

(1) GENERAL. — When removing defective components from printed circuit boards it is recommended that a 6.3-volt ac type, light duty (35-watts), soldering iron be employed. Turn the instrument off and ground the frame of the iron or the ground terminal (white wire-6.3-volt side) of its transformer to the metal framework of the instrument. Use a heat sink and only a small amount of solder during this operation. When the solder begins to flow, bend the folded-over portion of the component leads, on the rear side of the printed circuit board, into an upright position and carefully remove the component. Check the boards carefully for stray solder globals or splashes which may cause shorts.

(2) REMOVAL OF CABINET. — Refer to Section 2, paragraph 2-1 for this procedure.

(3) REMOVAL OF CRT. — Remove the following items in the order listed: Crt bezel, HV anode cap, pin connectors on neck of crt, and the crt socket. Loosen crt clamp and slide crt forward to remove.

WARNING

The type 4QP crt has been chemically coated to insure optimum performance under adverse environmental conditions. To avoid irritation to the skin, handle the crt with gloves. Goggles must also be worn. Store crt horizontally in a safe location.

(4) REMOVAL OF CRT SHIELD. — Remove the two screws at the top of the horizontal amplifier printed circuit board (Z402) which fasten it to the upper left hand support member. Remove the support member itself. Remove screws from L401-L402 support bracket. Loosen the support member at bottom of printed circuit board Z402 and swing board outward about 30 degrees. Remove screw on the crt shield mounting tab which fastens it to center bulkhead. Remove pilot lamp socket and the unblanking wire from its clip on the rear of the crt shield. Remove four screws which fasten crt shield to front panel. Elevate rear or neck portion of crt shield until center mounting tab is clear of bulkhead and slip the shield backward until it is free of instrument framework.

(5) CLEANING GRATICULE AND FILTER. — If the crt graticule and filter are removed for cleaning, use the following procedures: moisten a soft clean rag with an anti-static plastics cleaner. Clean all surfaces of the graticule and filter. Add more anti-static solution to the rag and apply an even coat to the crt face and inside surface (nearest crt face) of the graticule and filter before they are placed in the bezel.

d. LOCATION OF PARTS. — All electrical components of Oscilloscope AN/USM-117 are illustrated in figures 6-1 through 6-23. Cross reference of all illustrated parts may be found in table 7-1.

Figure 6-1. Oscilloscope AN/USM-117, Chassis Assembly, Top View

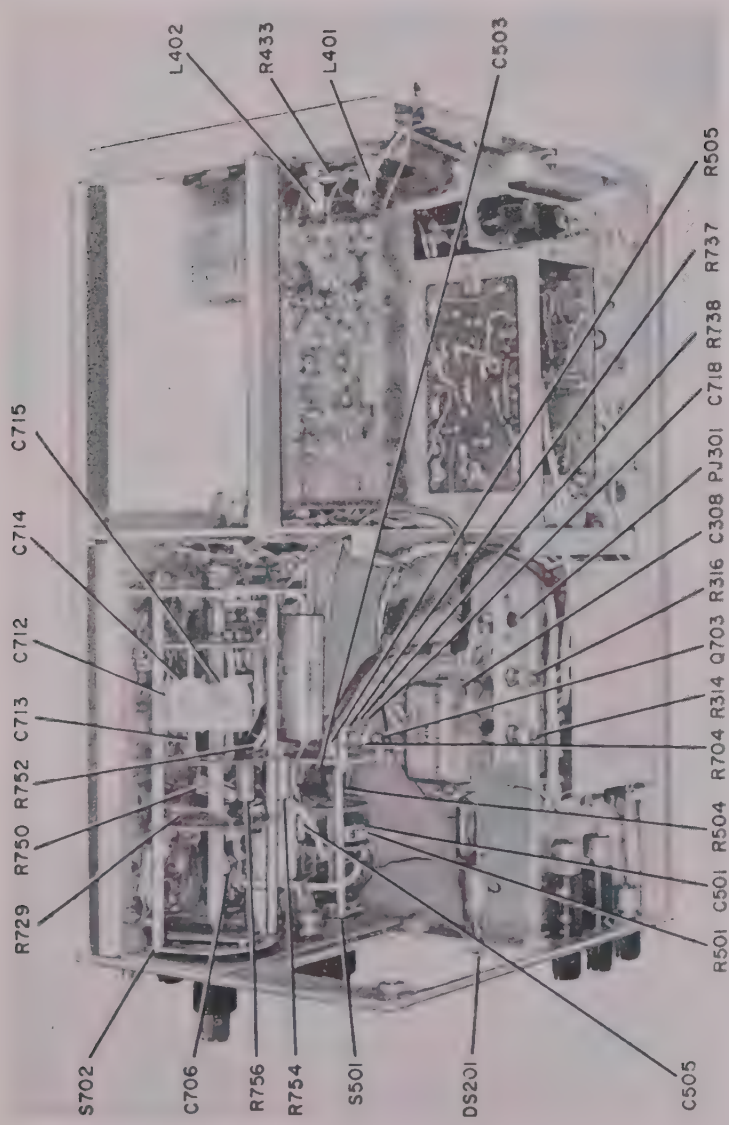

Figure 6-2. Oscilloscope AN/USM-117, Chassis Assembly, Side View

Figure 6-3. Oscilloscope AN/USM-117, Chassis Assembly, Bottom View

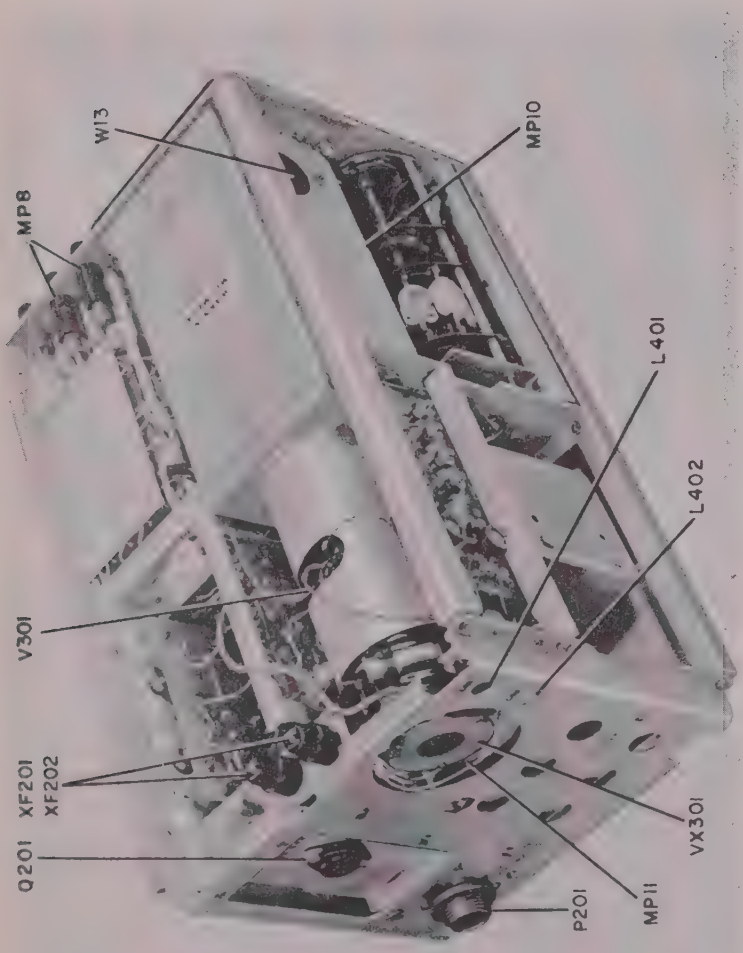

Figure 6-4. Oscilloscope AN/USM-117, Chassis Assembly, Rear View

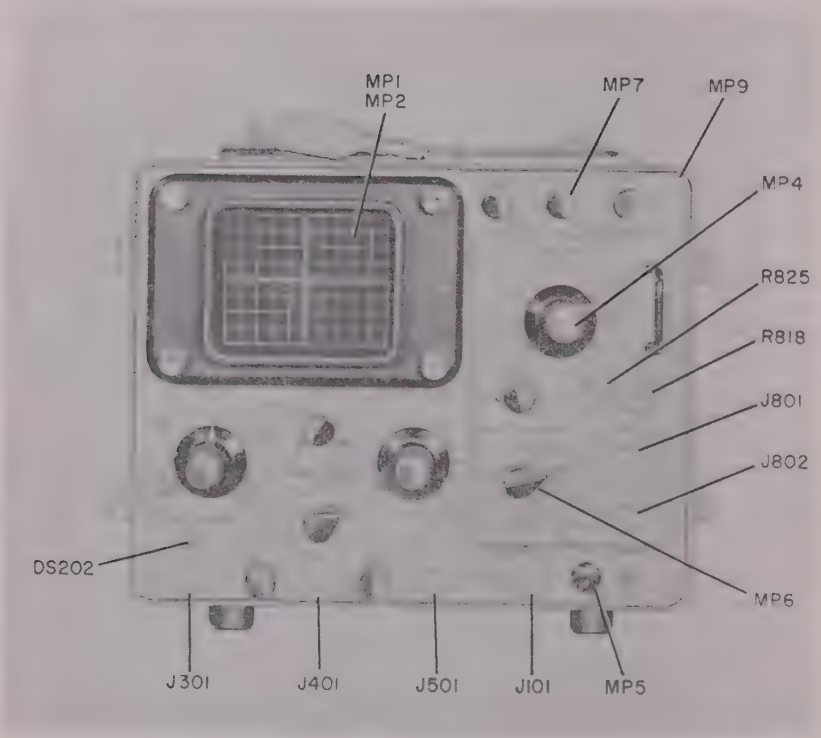

Figure 6-5. Oscilloscope AN/USM-117, Front Panel

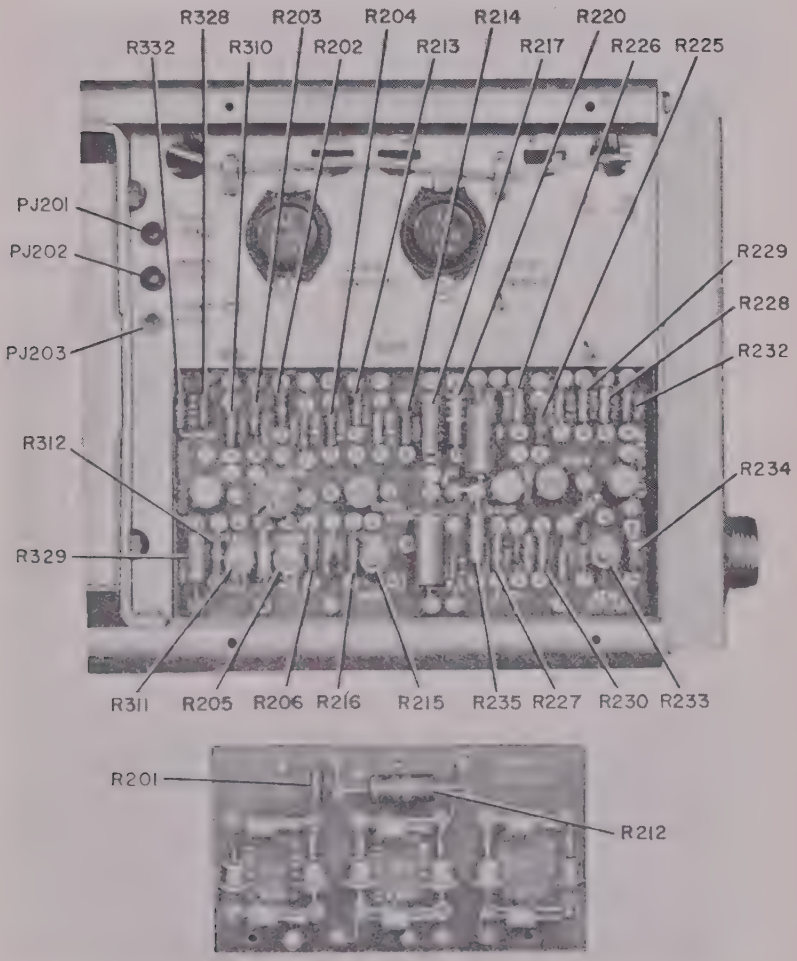

Figure 6-6. Oscilloscope AN/USM-117, Low Voltage Power Supply, Circuit Boards Z201 and TB201 (Sheet 1 of 2)

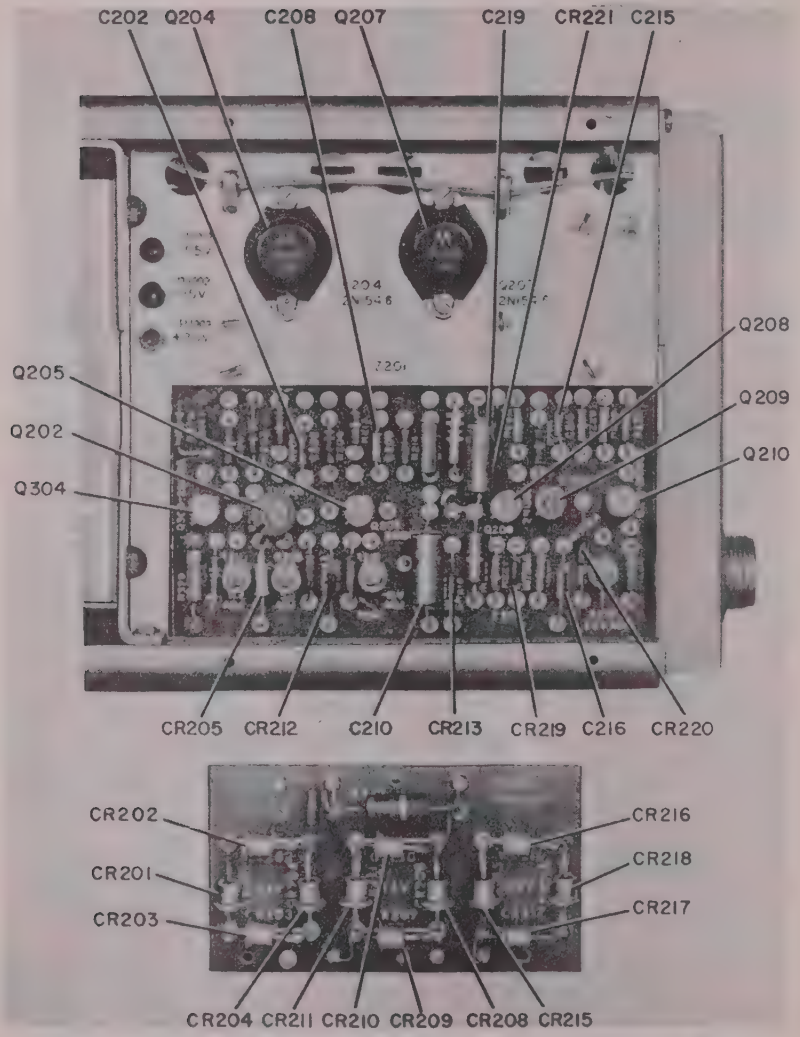

Figure 6-6. Oscilloscope AN/USM-117, Low Voltage Power Supply, Circuit Boards Z201 and TB201 (Sheet 2 of 2)

Figure 6-7. Oscilloscope AN/USM-117, Printed Circuit Board Z201, Rear View

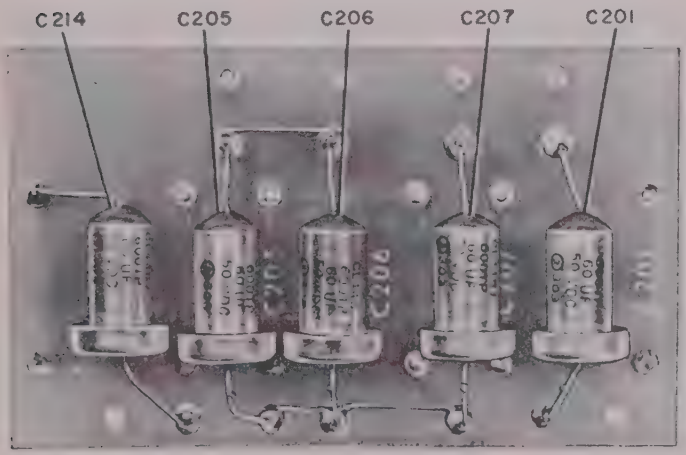

Figure 6-8. Oscilloscope AN/USM-117, Terminal Board TB201, Rear View

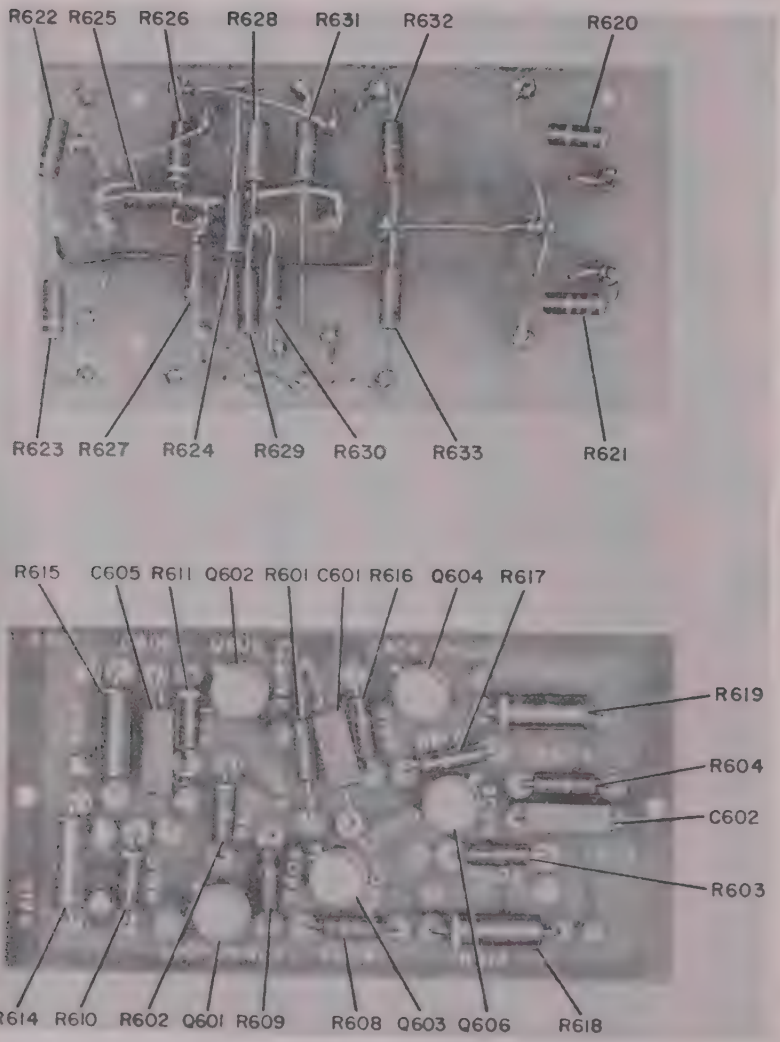

Figure 6-9. Oscilloscope AN/USM-117, Vertical Post Amplifier, Circuit Boards DL603 and Z601

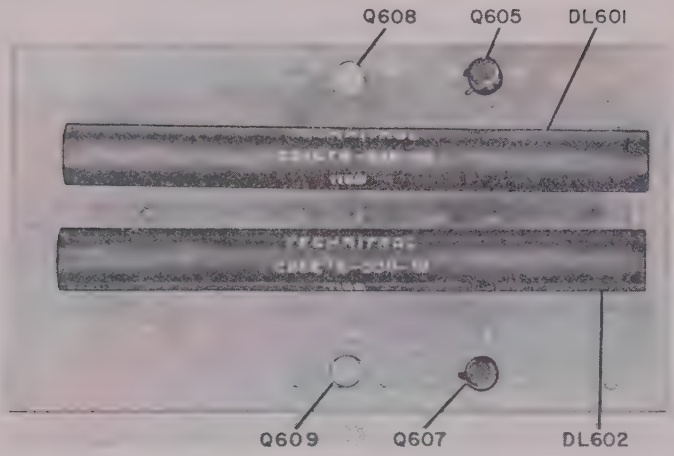

Figure 6-10. Oscilloscope AN/USM-117, Terminal Board DL603, Rear View

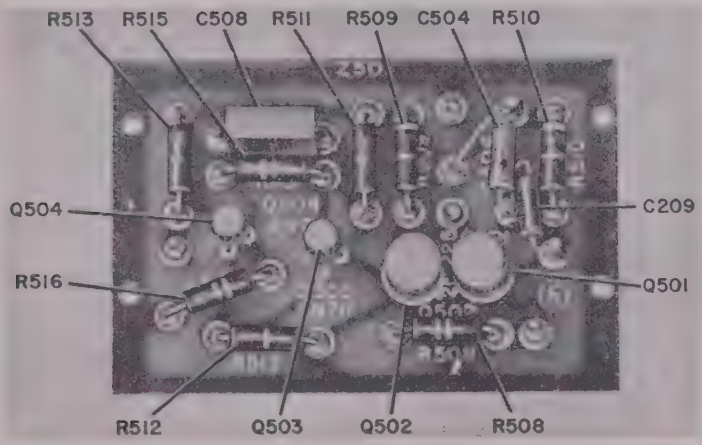

Figure 6-11. Oscilloscope AN/USM-117, Sweep Trigger, Printed Circuit Board Z501

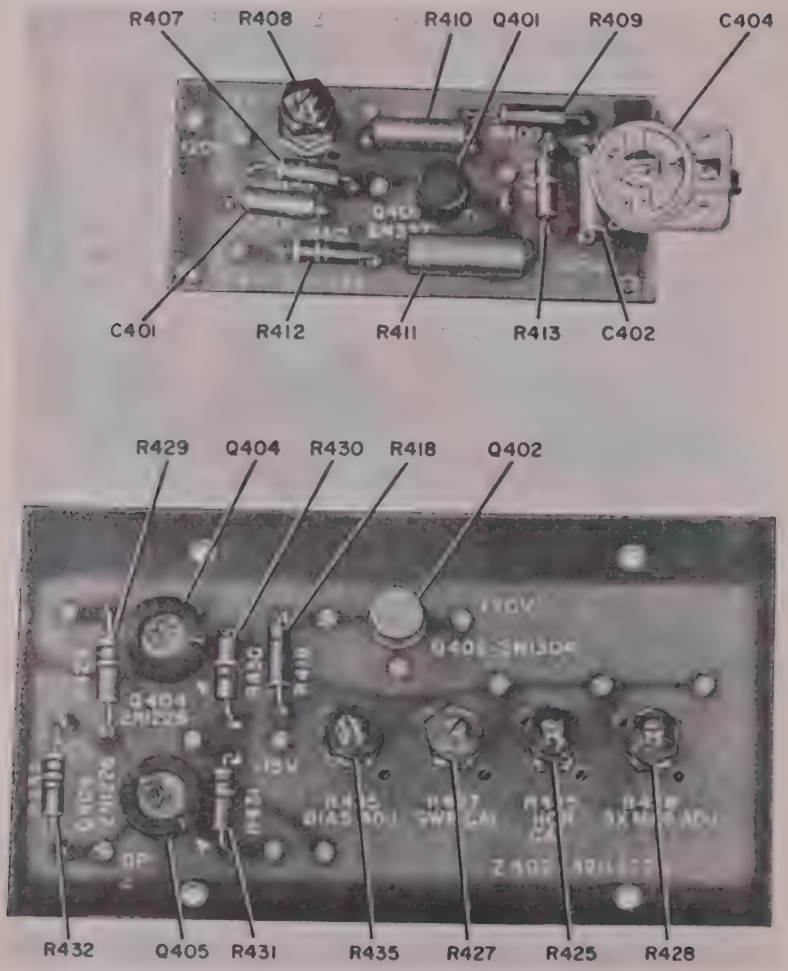

Figure 6-12. Oscilloscope AN/USM-117, Horizontal Amplifier, Printed Circuit Boards Z401 and Z402

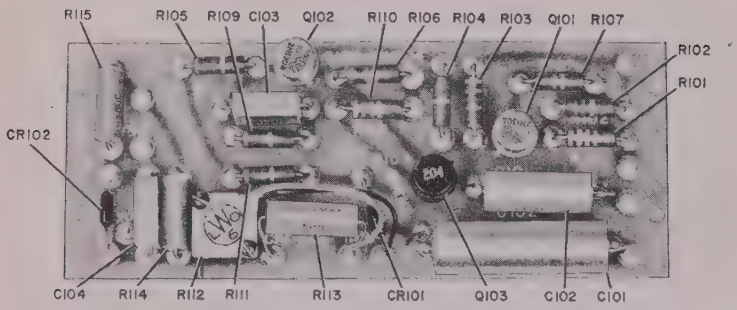

Figure 6-13. Oscilloscope AN/USM-117, Calibrator, Printed Circuit Board Z101

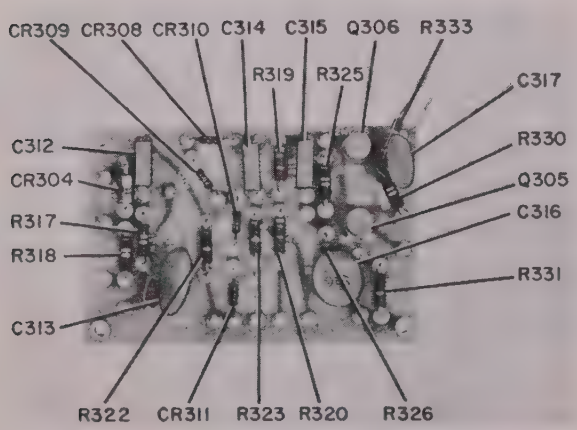

Figure 6-14. Oscilloscope AN/USM-117, Printed Circuit Board Z301

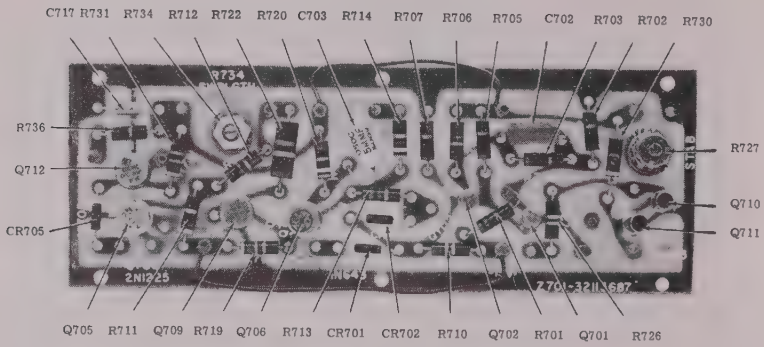

Figure 6-15. Oscilloscope AN/USM-117, Sweep Generator, Printed Circuit Board Z701

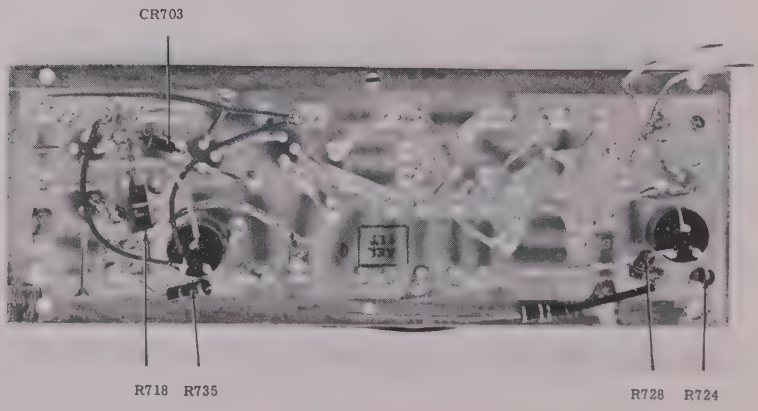

Figure 6-16. Oscilloscope AN/USM-117, Sweep Generator, Printed Circuit Board Z701, Rear View

Figure 6-17. Oscilloscope AN/USM-117, Emitter Follower Assembly, Front View

Figure 6-18. Oscilloscope AN/USM-117, Emitter Follower Assembly, Rear View

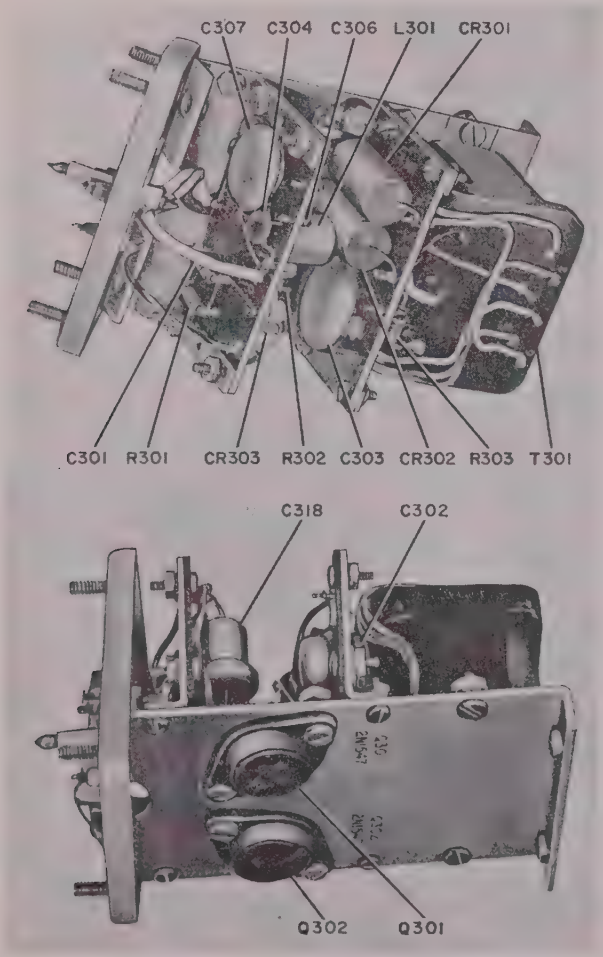

Figure 6-19. Oscilloscope AN/USM-117, High Voltage Assembly

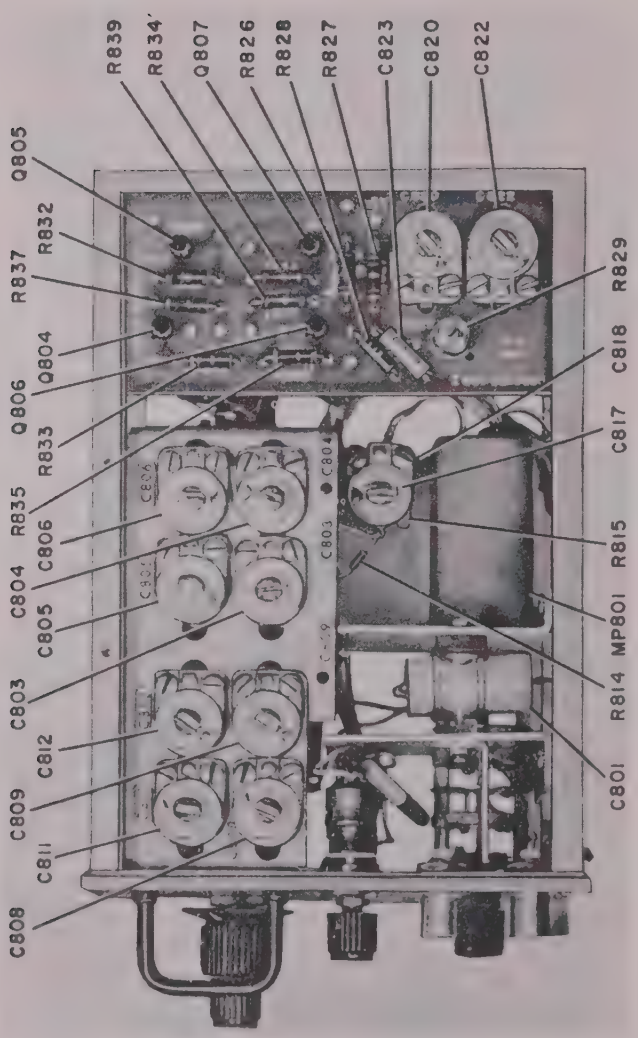

Figure 6-20. Oscilloscope AN/USM-117, Vertical Plug-in, Front View

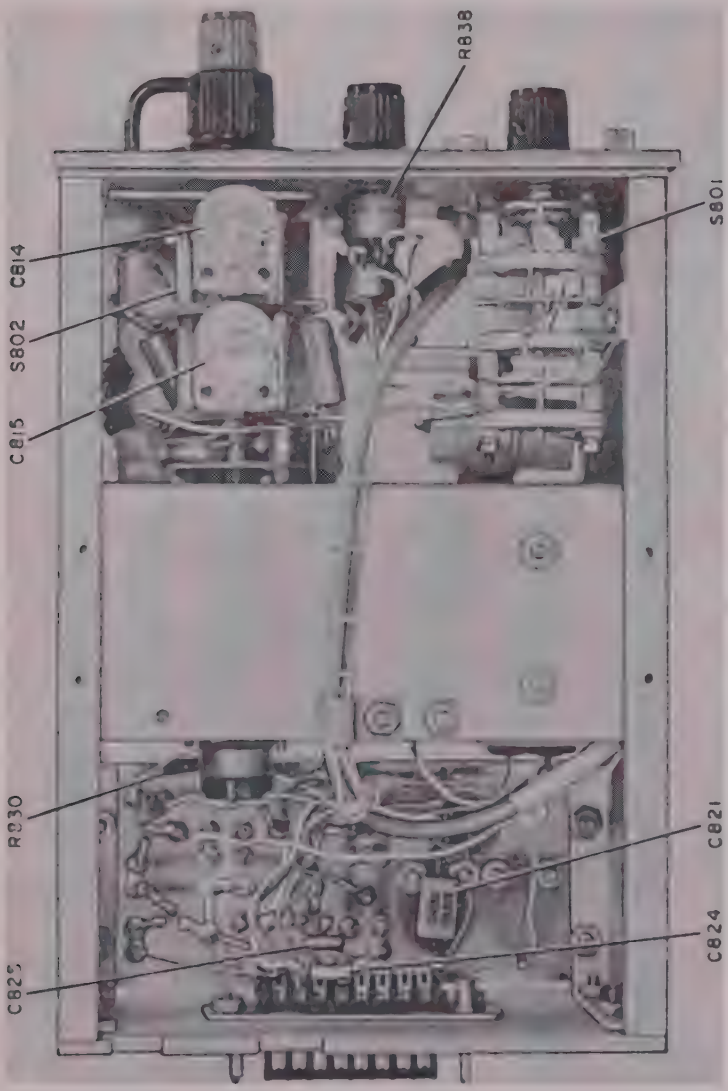

Figure 6-21. Oscilloscope AN/USM-117, Vertical Plug-in, Rear View

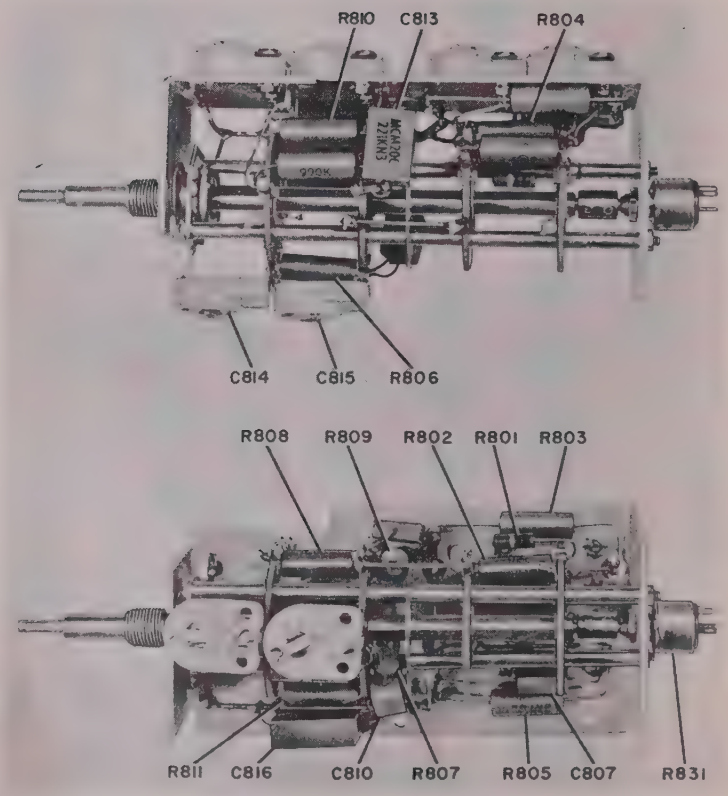

Figure 6-22. Oscilloscope AN/USM-117, Switch Assembly S802

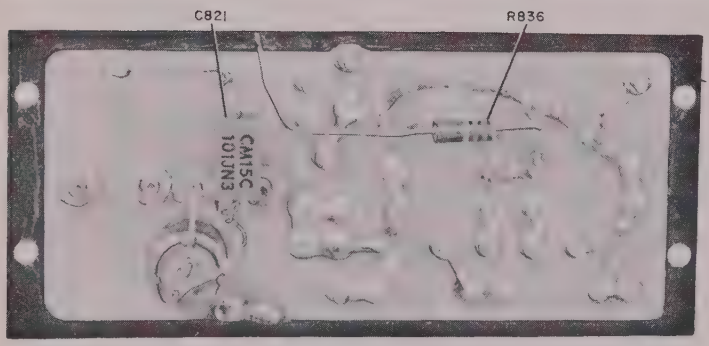

Figure 6-23. Oscilloscope AN/USM-117, Printed Circuit Board Z801, Rear View

SECTION 7

PREVENTIVE MAINTENANCE INSTRUCTIONS

7-1. Scope of Maintenance

The maintenance duties assigned to the operator and organizational repairman of the equipment are listed below together with a reference to the paragraphs covering the specific maintenance functions.

a. Daily preventive maintenance checks and services (para 7-4).

b. Weekly preventive maintenance checks and services (para 7-5).

c. Monthly preventive maintenance checks and services (para 7-6).

d. Quarterly preventive maintenance checks and services (para 7-7).

e. Cleaning (para 7-8).

f. Touchup painting (para 7-9).

7-2. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 7-8 and 7-9 cover routine systematic care and cleaning essential to proper upkeep and operation of the AN/USM-117.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (para 7-4 through 7-7) outline functions to be performed at specific intervals. These checks and services are to maintain Army electronic equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and the normal conditions; the References column lists the illustrations, paragraphs, or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective action indicated, higher level maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38-750.

7-3. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of the equipment are required daily, weekly, monthly, and quarterly.

a. Paragraph 7-4 specifies the checks and services that must be accomplished daily (or at least once each week if the equipment is maintained in standby condition).

b. Paragraphs 7-5, 7-6, and 7-7 specify additional checks and services that must be performed on a weekly, monthly, and quarterly basis, respectively.

7-4. Operator's Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Completeness.....	See that the equipment is complete (appx II)....	None.
2	Exterior surfaces.....	Clean the exterior surfaces, including the panel (para 7-8). Check the graticule lens for scratches.	None.
3	Connectors.....	Check the tightness of all connectors.....	None.
4	Controls and indicators...	While making the operating checks (item 5), observe that the mechanical action of each switch and control is smooth and free of external or internal binding, and that there is no excessive looseness.	None.
5	Operation.....	During operation, be alert for any unusual performance or condition.	None.

7-5. Organizational Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Cables.....	Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, stripped, or worn excessively.	None.
2	Handles and latches.....	Inspect handles for looseness. Replace or tighten as necessary.	None.
3	Metal surfaces.....	Inspect exposed metal surfaces for rust and corrosion. Touchup paint as required (para 7-9).	None.

7-6. Organizational Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Pluckout items.....	Inspect seating of pluckout items. Make certain that the crt tube clamp grips the crt base tightly.	None.
2	Jacks and plugs.....	Inspect jacks and plugs for snug fit and good contact.	None.

7-6. Organizational Monthly Preventive Maintenance Checks and Services Chart (cont)

Sequence No.	Item to be inspected	Procedure	References
3	Transformer terminals.....	Inspect the terminals on the power transformer. All nuts must be tight. There should be no evidence of dirt or corrosion.	None.
4	Printed circuit boards....	Inspect printed circuit boards for loose connections and cracks.	None.
5	Resistors and capacitors.	Inspect the resistors and capacitors for cracks, blistering, or other detrimental defects.	None.

7-7. Organizational Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item to be inspected	Procedure	References
1	Publications.....	See that all publications are complete, serviceable, and current.	DA Pam 310-4.
2	Modifications.....	Check DA Pam 310-4 to determine if new applicable MWO's have been published. All urgent MWO's must be applied immediately. All normal MWO's must be scheduled.	TM 38-750.

7-7. Organizational Quarterly Preventive Maintenance Checks and Services Chart (cont)

Sequence No.	Item to be inspected	Procedure	References
3	Spare parts.....	Check all spare parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	

7-8. Cleaning

Inspect the exterior of Oscilloscope AN/USM-117. The exterior surfaces must be free of dust, grease, and fungus.

a. Remove dust and loose dirt with a clean, soft cloth.

Warning: Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. DO NOT use near a flame. Avoid contact with the skin; wash off any that spills on your hands.

b. Remove grease, fungus, and ground-in dirt from the case and cover of the test set. Use a cloth dampened (not wet) with Cleaning Compound (FSN 7930-395-9542).

c. Remove dust or dirt from plugs and jacks with a brush.

d. Clean the front panel and control knobs with a soft clean cloth. If dirt is difficult to remove, dampen the cloth with water; use mild soap if necessary.

7-9. Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TB SIG 364.

APPENDIX

REFERENCES

Following is a list of references that are available to the operator and organizational, DS, GS, and depot maintenance repairmen of Oscilloscope AN/USM-117B.

DA Pam 310-4	Index of Technical Manuals, Technical Bulletins, Supply Manuals (types 7, 8, and 9), Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TB SIG 364	Field Instructions for Painting and Preserving Electronics Command Equipment.
TM 38-750	Army Equipment Record Procedures.

APPENDIX II

BASIC ISSUE ITEMS LIST

Section I. INTRODUCTION

A2-1. General

This appendix lists items for Oscilloscope AN/USM-117B, the component items comprising it, and the items which accompany it, or are required for installation, operation, or operator's maintenance.

A2-2. Explanation of Columns

An explanation of the columns in section II is given below.

a. Source, Maintenance, and Recoverability Codes (Column 1). Not used.

b. Federal Stock Number, Column 2. The Federal stock number for the item is indicated in this column.

c. Description, Column 3. The Federal item name, a five-digit manufacturer's code and part number are included in this column.

d. Unit of Issue, Column 4. The unit used as a basis of issue (e.g. ea, pr, ft, yd, etc) is noted in this column.

e. Quantity Incorporated in Unit Pack, Column 5. Not used.

f. Quantity Incorporated in Unit, Column 6. The total quantity of an item required to be on hand and necessary for the operation and maintenance of the equipment is given in this column.

h. Illustration, Column 8.

(1) Figure number, column 8a. The number of the illustration in which the item is shown is indicated in this column.

(2) Item or symbol number, column 8b. The call out number used to reference the item in the illustration appears in this column.

A2-3. Federal Supply Codes

This paragraph lists the Federal supply code with the associated manufacturer's name.

Code	Name
81349	Military Specifications

(1) SOURCE CD (A)	(1) MAINT. CD (B)	(1) REC. CODE (C)	(2) FEDERAL STOCK NUMBER	MODEL 1	2	3	4	5	6	(3) DESCRIPTION	(4) UNIT OF ISSUE	(5) QTY INC IN UNIT PACK	(6) QTY INC IN UNIT	(7) QTY AUTH	(8) ILLUSTRATIONS (A) FIGURE NUMBER	(8) ILLUSTRATIONS (B) ITEM OR SYMBOL NUMBER
			BASIC ISSUE ITEMS LIST													
			6625-930-6835							OSCILLOSCOPE AN/USM-117B					1-1	
			ORD THRU AGC							TECHNICAL MANUAL TM 11-6625-640-15			1	1		
										NOTE: For technical manuals the quantity indicates the maximum number of copies authorized for packing (or issue) with the equipment. Where a number of these equipments are concentrated in a small area, the quantity on hand may be reduced to practical levels. Excess publications must be returned to publication supply centers through AG channels.						
			5935-201-2411							ADAPTER, CONNECTOR UG-274A/U			2	2	1-1	J902
			5935-807-3895							ADAPTER, CONNECTOR UG-1035/U			4	4	1-1	J903
			5935-149-3534							ADAPTER, CONNECTOR UG-273/U			2	2	1-1	J904
			5935-149-3914							ADAPTER, CONNECTOR UG-255/U			2	2	1-1	J905
			[illegible]							CABLE ASSEMBLY, POWER ELECTRICAL CX-4704A/U			1	1	1-1	W1
			[illegible]							CABLE ASSEMBLY, RADIOFREQUENCY CG-409E/U (8 ft)			2	2	1-1	W2
			6625-930-6836							COVER, OSCILLOSCOPE CW-541B/USM-117			1	1	1-1	
			[illegible]							FUSE, CARTRIDGE: 81349; F02GR500A			2	5	1-1	F201, F202
			6625-930-6838							OSCILLOSCOPE OS-106B/USM-117			1	1	1-1	
			6625-930-6837							OSCILLOSCOPE SUBASSEMBLY, VERTICAL CHANNEL, HIGH GAIN PREAMPLIFIER MX-2996B/USM-117			1	1	1-1	
			6625-973-4775							PROD, TEST MX-4073/U			2	2		P1
										NOTE: The following items and their quantities are mounted, in or on equipment listed, for storage purposes.						

(1)			BASIC ISSUE ITEMS LIST															
(A) SOURCE CD	(B) MAINT. CD	(C) REC. CODE	(2) FEDERAL STOCK NUMBER	MODEL 1	2	3	4	5	6	(3) DESCRIPTION	(4) UNIT OF ISSUE	(5) QTY INC IN UNIT PACK	(6) QTY INC IN UNIT	(7) QTY AUTH	(8) ILLUSTRATIONS (A) FIGURE NUMBER	(B) ITEM OR SYMBOL NUMBER
										AN/USM-117B (continued)						
										OSCILLOSCOPE OS-106B/USM-117						
			5920-281-0224							FUSE, CARTRIDGE: 2						
										COVER, OSCILLOSCOPE CW-541B/USM-117						
			5935-201-2411							ADAPTER, CONNECTOR UG-274A/U: 2						
			[illegible]							ADAPTER, CONNECTOR UG-1035/U: 4						
			5935-149-3534							ADAPTER, CONNECTOR UG-273/U: 2						
			5935-149-3914							ADAPTER, CONNECTOR UG-255/U: 2						
			5995-985-7744							CABLE ASSEMBLY, POWER, ELECTRICAL CX-4704A/U: 1						
			[illegible]							CABLE ASSEMBLY, RADIOFREQUENCY CG-409E/U: 2						
			[illegible]							PROD, TEST MX-4073/U: 2						

APPENDIX III

MAINTENANCE ALLOCATION

Section I. INTRODUCTION

A3-1. General

This appendix provides a summary of the maintenance operations covered in the equipment literature for Oscilloscope AN/USM-117B. It authorizes levels of maintenance for specific maintenance functions on repairable items and components and the tools and equipment required to perform each function. This appendix may be used as an aid in planning maintenance operations.

A3-2. Explanation of Format for Maintenance Allocation Chart

a. Group Number. Group numbers correspond to the reference designation prefix assigned in accordance with ASA Y32.16, Electrical and Electronics Reference Designations. They indicate the relation of listed items to the next higher assembly.

b. Component Assembly Nomenclature. This column lists the item names of component units, assemblies, subassemblies, and modules on which maintenance is authorized.

c. Maintenance Function. This column indicates the maintenance level at which performance of the specific maintenance function is authorized. Authorization to perform a function at any level also includes authorization to perform that function at higher levels. The codes used represent the various maintenance levels as follows:

Codes	Maintenance Category
O/C	Operator/Crew
O	Organizational
F	Direct support
H	General support
D	Depot

d. Tools and Equipment. The numbers appearing in this column refer to specific tools and equipment which are identified by these numbers in Section III.

e. Remarks. Self explanatory.

3. Explanation of Format for Tool and Test Equipment Requirements

The columns in the tool and test equipment requirements chart are as follows:

a. Tools and Equipment. The numbers in this column coincide with the numbers used in the tools and equipment column of the MAC. The numbers indicate the applicable tool for the maintenance function.

b. Maintenance Category. The codes in this column indicate the maintenance category normally allocated the facility.

c. Nomenclature. This column lists tools, test and maintenance equipment required to perform the maintenance functions.

d. Federal Stock Number. This column lists the Federal stock number.

e. Tool Number. Not used.

SECTION II. MAINTENANCE ALLOCATION CHART

MAINTENANCE ALLOCATION CHART

GROUP NUMBER	COMPONENT ASSEMBLY NOMENCLATURE	MAINTENANCE FUNCTIONS											TOOLS AND EQUIPMENT	REMARKS
		INSPECT	TEST	SERVICE	ADJUST	ALIGN	CALIBRATE	INSTALL	REPLACE	REPAIR	OVERHAUL	REBUILD		
	[illegible]	C/O	"	O/C	O/C H								2,4,5,6, 2 thru 7 ,	
	[illegible]									H	D		1 thru 9	
	[illegible]									.			,	
	[illegible] MX-2996B/USM-117								O	H			10 ,	
	[illegible]									H			9	

TOOL AND TEST EQUIPMENT REQUIREMENTS

TOOLS AND EQUIPMENT	MAINTENANCE CATEGORY	NOMENCLATURE	FEDERAL STOCK NUMBER	TOOL NUMBER
		AN/USM-117B (continued)		
1	D	GENERATOR, ELECTRONIC MARKER AN/USM-108	6625-987-9564	
2	H,D	GENERATOR, SIGNAL AN/URM-127	6625-783-5965	
3	H,D	GENERATOR, SIGNAL SG-299/U	6625-624-3516	
4	H,D	MULTIMETER ME-26D/U	6625-913-9781	
5	H,D	MULTIMETER TS-352B/U	6625-553-0142	
6	H,D	OSCILLOSCOPE AN/USM-140A	6625-987-6603	
7	H,D	TEST SET, ELECTRICAL METER TS-682A/GSM-1	6625-669-0747	
8	H,D	TEST SET TRANSISTOR TS-1836/U	6625-893-2626	
9	H,D	TOOL KIT, ELECTRONIC EQUIPMENT TK-100/G	5180-605-0079	
10	O	TOOLS AND TEST EQUIPMENT AVAILABLE TO REPAIRMAN-USER BECAUSE OF HIS ASSIGNED MISSION		

INDEX

SUBJECT	Paragraph (Figure) *Table
A	
Adjustments:	
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Calibrator	6-2e
CRT Alignment	6-2g
Geometry	6-2g
General	6-2e
High Voltage Power Supply	6-2
Horizontal Amplifier	6-2h
Low Voltage Power Supply	6-2f
Plug-in MX-2996/USM-117	6-2j
Probe, MX-2817/U	3-3h
Sweep Generator	6-2i
Test Equipment	6-2d
Vertical Post Amplifier	6-2j
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